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April 18, 1929

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Engineering News-Record

Devoted to Civil Engineering and Contracting

In this issue:

Deep Trench Emergency Intake for Pittsburgh Water-Works

Welding a Four-story Commercial Building

Relative Values of Public Utility Systems

Machine-Finished Asphalt Paving Adopted in California

Chlorination Relieves Ponding on Sewage Filter Beds

Basic Principles of Concrete Making—Second Article

A Farewell Word on the Venturi Meter—By Clemens Herschel

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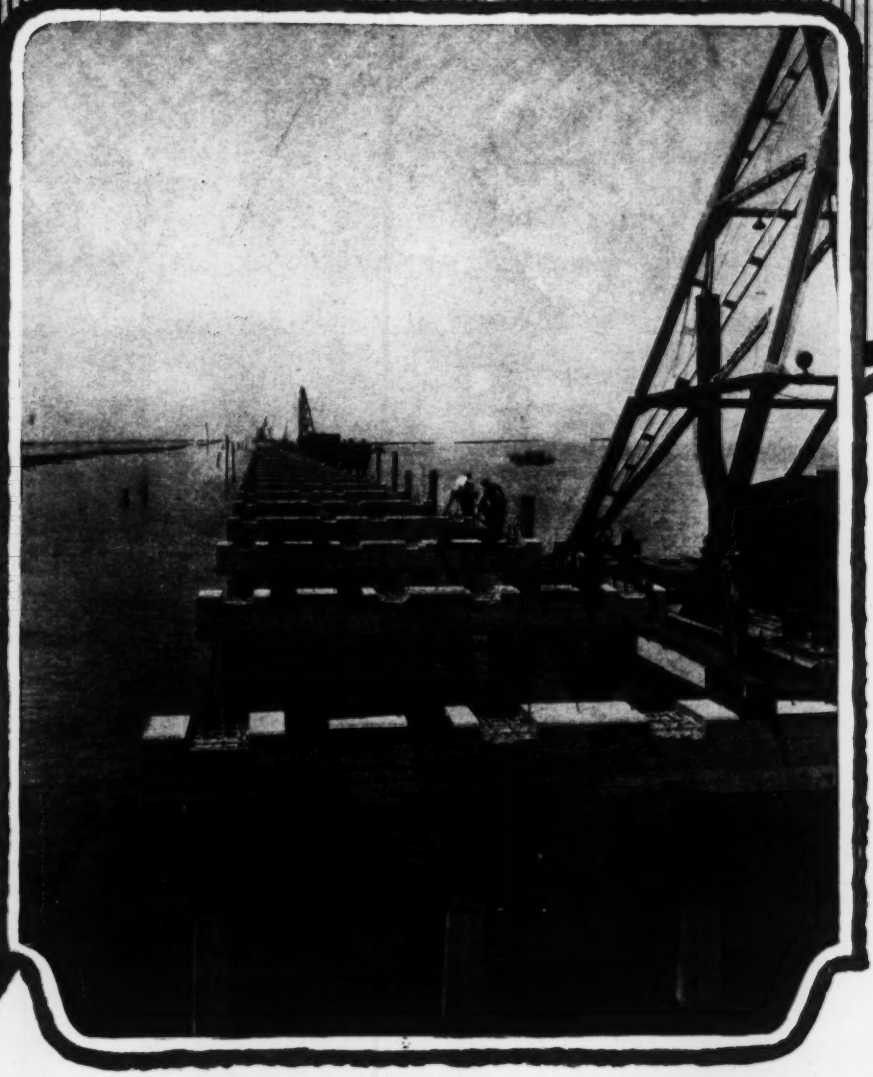

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Volume 102 NEW YORK, APRIL 18, 1929 Number 16

Legs Are Expensive

"SOMEONE will break a leg in that hole and it will be a damn expensive leg," once said J. J. Scully, general manager of the Canadian Pacific Railway, pointing to a hole in a station platform caused by dropping a heavy casting from an express car door. Safety consists not alone in making things safe once but in keeping them safe. When the train from which the casting had been dropped drew into the station the platform was safe and sound, but when it left the platform had a potential danger point for a passenger on a following train. The same is true of a construction job. The walkways or stairs or hoist towers may have been safe when they were put up, but are they now? That question should stir every construction foreman to keep his eye open for the frequently occurring defects in his safety measures which come through change in temporary structures or through accident. Eternal vigilance is the price of real safety—but it pays. This is well worth remembering at the present time, when rules and practice of construction safety are much under discussion. Maintaining safety is quite as important as installing it, but rules and codes cannot provide this maintenance. Unless the contractor himself is imbued with the desire to make and keep his work safe he may often learn that legs are expensive.

Growing Public Opinion

REACTION against private toll bridges, of which the California report is one of the current evidences, is a recent rapidly growing movement. Its genesis and progress may be charged in large part to ill-advised financial methods on the part of toll-bridge promoters. This is highly unfortunate, since toll construction under private auspices has distinct virtues, because of which *Engineering News-Record* advocated this form of construction a number of years ago, before private toll bridges were a commercial reality. There are weighty arguments on both sides of the question, but events of recent years have tended to shift the balance strongly against the private toll bridge. Whether this conclusion is justified or not, there can be no doubt that the public attitude is shaping up progressively against the system. So far, legislators have been slowest to realize the force of the popular attitude, and this applies especially to the national Congress, which in its recent sessions has continued to grant bridge franchises freely, in a manner that is bound to intensify the growth of popular opposition. At the present rate of development it is but a question of a short time before legislatures, including Congress, will yield to popular sentiment and place rigid restrictions on private toll-bridge construction, perhaps to the extent of killing off the system. The growth of the movement is one of the most interesting features of civil engineering activities of the current decade. Its further progress, therefore, is of direct concern to the entire profession.

Ocean Outfall Problems

RECENT experience with several sewer outfalls built into the open ocean along the southern California coast has been unsatisfactory. Either the design employed was not fundamentally sound or something was lacking in the construction plan. Sometimes sand has entered and almost choked off the flow, or the ocean bottom has shifted, causing settlement of the outfall, or joints between pipe sections have given way and caused objectionable leakage. Such cases have afforded valuable experience and have contributed to the knowledge of the art. At least it has become evident that danger attends the laying of short lengths of large-diameter pipe on or close to the ocean bottom—adequate trenching or a suitable substructure should be provided, and where some deeply embedded outfall could be built, perhaps by the tunneling method, that would be preferable. The design of the discharge end of the pipe itself is a point worthy of special attention. This should be so arranged that, even under the stirring effect of heavy wave action at times of minimum sewage flow, sand will not be carried into the pipe. As the need for ocean outfalls extends, greater importance attaches to design and methods of construction. A general survey of the subject as a whole and compilation of available data by some technical society committee would be a valuable service to the profession, particularly opportune just now.

Faulty Intakes

WATER intakes in the East furnish a record of experience hardly more satisfactory than that of sewer outfalls on the Pacific Coast. In recent years intake reconstruction because of structural failure of concrete has been of too frequent occurrence for complacent regard. A notable example is recorded in this issue. There are other no less complete failures in power-plant intake structures. The Pittsburgh failure, however, is an alarm call to which engineers may not remain deaf. A structure whose failure hazards the water supply of a great city cannot be left to any chance in respect to its permanent integrity. And chance is exactly what has been allowed too often to control concrete conduit construction in trenches having a bottom upflow of water as was the case at Pittsburgh both when the old intake was put in some years ago and while the new intake was being constructed recently. There are hazards in placing concrete on a boiling bottom which have been too often neglected. Until the concrete seal sets and hardens the boiling must be checked. In the new intake work,

it will be observed, this was accomplished by drains to relieve for a time the upward pressure and by tarpaulin blankets to retain the surface soil. Isolation of bottom troubles by cross-walls dividing the bottom into sections, and exact regard for concrete quality, give confidence that the new intake concrete will not have the misfortune of the old. It is increasingly obvious from intake failures that no less precaution can be countenanced in good engineering. Indeed, if we have polluted water to deal with, or salt water, as is often the case in power-plant intakes, the concrete hazards to be guarded against may be far greater than those at Pittsburgh. In short, a buried intake structure of concrete or any other material cannot have its construction too well guarded.

No Power Excess

BEARING on the question whether the marketing of the large block of Boulder dam power would upset the power-supply economics of the Southwest, interesting facts are given in a survey prepared by Spencer Trask & Company to reassure investors in California power companies. The survey points out that Boulder Canyon dam, if ready to produce power today, could supplant the four larger companies of southern California with their annual output of 3,250,000,000 kw.-hr. and have 250,000,000 kw.-hr. to spare. But development of that amount cannot possibly take place for at least seven and more probably ten years, and by that time the region could absorb its entire output. As the power units are likely to be brought into service progressively, each increment will be partly offset by the normal increase in demand. By converting present plants and those which will be built between now and the time the first Colorado River power is available into stand-by plants for emergency or peak-load demand, the construction of a large power plant in either Boulder or Black Canyon should have no detrimental effect upon the power situation in southern California.

Railway Interrelations

PAYMENT recently of a 100 per cent dividend on stock of the Michigan Central Railroad raises the question as to what makes such a payment possible in this day of low average railroad income, also as to how much of this return goes to the government under the recapture provisions of the transportation act. The first question a glance at the map of the New York Central system, of which the Michigan Central is a part, and an examination of the financial set-up of the road will largely clear up. Its 1,800 miles of track are mostly concentrated in a thickly populated industrial region and its main line is an important part of the New York Central system between Chicago and New York. Its income from such a region naturally would be high. The second question is not so easily answered. In its financial set-up only a small proportion of the Michigan Central's total capital is in stock, about $18,000,000 of its total of about $135,000,000, consequently a large dividend on stock does not mean a large return on the total investment. As to how much of this return is owed to the government under the Transportation Act no one can say definitely; it hinges in part on a pending decision of the U. S. Supreme Court in the O'Fallon case. Much depends upon that court's ruling as to what constitutes a railroad system. Judging by what the court said in the five-cent fare case of the rapid transit system of New York, the essential character of this interrelation between one railway and its controlled line must be clearly shown before the latter may be considered as part of the larger system in so far as its financial accounting is concerned.

A Regrettable Loss

IN THE midst of the remarkable events that recently befell the Mount Hope and Detroit bridges, the leader of the former enterprise has been suddenly taken away by death. It is an untimely loss, for Mr. Coleman's influence had been unusually important in leading to prompt and progressive solution of the serious problem presented at Mount Hope. His enlightened attitude, moreover, was largely responsible for the company's action in making available to public knowledge the startling facts which led to the decision to rebuild the cables. So great an addition to our knowledge of materials promises to flow from the event that this attitude is of outstanding significance. That he could not live to see the completion of the enterprise which he fathered is therefore a subject for more than ordinary regret.

Rationalizing Formwork

CALCULATED design of concrete forms is coming rapidly into recognition by constructors. Today concrete builders are considering not merely formwork which will stand up under load but formwork whose displacement can be accurately predicted. The reasons are evident. Formwork occupies a key position in concrete construction. In a complex structure it is easily one of the largest costs which the contractor must figure and it is the sole dependence of the designer for integrity of surface and line in his structures. Elementally it is of chief concern to the designer that displacement be eliminated. In practice the obligation is placed on the constructor. It is bringing about a new order of formwork thinking.

Mere bulk and solidity of structure is no longer countenanced as an adequate solution of the problem of eliminating displacement. Resort is being had to the science of statics and knowledge of the properties of materials and more recently to tests of assembled formwork units. A notable example of the last practice is furnished by the two articles by A. G. Hampton which we recently published (March 28 and April 4). His tests are a praiseworthy undertaking to disclose the facts upon which a calculated engineering design can be predicated. The actual findings are well enough explained in the two articles; they are highly indicative in all instances and in many instances afford specific values that can be put to direct use. In a broader aspect they are encouraging evidence of the possible yield that may be obtained by applying research methods to practical construction problems.

Coming back specifically to formwork, however, the possibilities of rational design should not be overestimated. A form has to be designed for many variables in locating conditions. Allowable form displacement has many values. There are many possible economic permutations between lumber units and labor units. In appraising their relative value, engineering can be reasonably competent if it is informed accurately on fundamental strength and displacement values. It is these that the tests reported by Mr. Hampton undertake to give.

They are ample to encourage much more extended investigation of the elements of form design and construction.

Utilities and Public Relations

INTERPRETATIONS of contracts between cities and public utilities are matters primarily for the state courts. Briefly, this is what the U. S. Supreme Court said in setting aside the injunction by which the Interborough Rapid Transit Company had checkmated the city of New York in its attempt to force the company to live up to its contract for the maintenance of a five-cent fare on the city's subways.

The rapid transit company operates the older of the two subway systems of New York and the elevated railways in the boroughs of Manhattan and the Bronx. It leases the elevated lines, owns part of the subway system and its equipment. The remainder is owned by the city. The company operates the subways and elevated under contracts with the city which stipulate that the passenger fare shall not be in excess of five cents. Despite high earnings on the subways, losses on the elevated lines in recent years had reduced the transit company's income to a point where it claimed that the five-cent fare was confiscatory. Thereupon it began making plans to collect a seven-cent fare. The city countered by starting action in the state courts to force the transit company to live up to its contract, but before the city's action got under way the company succeeded in getting the matter out of local courts by obtaining an injunction against the city and the transit commission in the Federal District Court. The case was then taken to the United States Supreme Court on appeal.

Such a method of taking local matters out of the jurisdiction of local courts does not meet with the approval of the Supreme Court. "The effect of the contracts," it says, "depends upon the proper construction of state statutes—a matter primarily for determination by local courts." This is sound doctrine. All too frequently public utilities enter into agreements or contracts with municipalities into which they might not have entered but for the belief that when the agreements become irksome they can take them from court to court with good prospect of getting the desired interpretation.

Another significant statement of the Supreme Court concerns the company's claim that under the "just and reasonable" rate clause of the state law the contract could not fix an inflexible rate of fare. With this view the court says it cannot agree. Without passing upon whether the contract should or should not be changed in so far as it applies to fares on the whole Interborough system—subways and elevated—the court states that "the franchise contract of 1912 was subject to statute and by statute now can be changed." In other words, the company—or any other public utility company—cannot invalidate a fixed-fare contract by resorting to a general law which was in effect when the contract was signed. The contract between the Interborough Rapid Transit Company and the city of New York was made part of a state statute. If it is to be changed, the court says, it must be by revision of that statute through application to the legislature by the parties to the contract, not by resort to court procedure. This finding also emphasizes the necessity for cordial relations between utility companies and the municipalities which they serve.

Viewed broadly, the decision should go far toward leading cities and their utilities to live together on satisfactory terms. When both parties know that responsibility for unsatisfactory conditions can be passed to outsiders, be they individual arbiters or courts, there is a natural tendency to seek improper advantages. There would be less bickering in our cities over rates of all kinds if more of such matters were required to be settled by mutual agreement and fewer by court actions.

Welding—A New Design Medium

ACCEPTANCE of structural welding as a new design medium goes along more slowly than might be expected. The mere use of welding to make structural joints has, on the other hand, enjoyed a phenomenal increase. Between these two methods of measuring growth there is a vast difference, and it is the development of a proper appreciation of this difference that now confronts the structural fraternity as a fundamental problem. Analysis of a majority of the currently welded structures reveals few instances reflecting the unhampered thinking that a new design medium such as welding should offer.

From its beginning the art of welding has been retarded, first by its original conception as a form of magic that would eliminate riveting entirely, and second by hasty assumption that such elimination is possible merely by substituting weld beads for rivets. That welding will not and should not be regarded as a substitute for riveting but only as a supplementary method of steel connection which will effect economies over rivets under certain easily recognizable conditions is gradually being appreciated. The second handicap to welding progress—failure to forget riveting precedents—is still very active, representing perhaps the greatest single obstacle that the welding art must overcome.

For instance, the fact that continuity is possible in riveted construction only at a considerable expense has led many designers to neglect it when welding is being considered. Riveted beam-to-column connections which utilize top and bottom angles and a web connection have caused welding designers to duplicate the practice blindly. The elimination of gusset plates with welding has been more readily accepted, as has the substitution of plates for angles as plate girder stiffeners. But by and large the customs and precedents of riveted practice have too often been reflected in high welding costs.

In view of such circumstances the recently built Hot Springs hotel addition (see *Engineering News-Record* of March 28, p. 490) deserves careful attention as a structure in which an honest attempt has been made to utilize welding on the basis of its own merits alone. Briefly, the outstanding characteristic of the structure was the development of ingenious forms of column splice and beam-to-column connection excellently suited to both shop and erection requirements. Furthermore, the floor-beams were supported on clip angles welded to the column in the shop instead of by shear welds between the webs of the beams and the column faces. No attempt was made to use welding where rivets or bolts would serve better. The work in all its phases represents intelligent application of highly developed skill.

Such practice reflects original welding thinking of a high order and should be emulated. We need more structures which have been designed for welding and fewer upon which welding has merely been used. How well this objective is attained will determine the progress of the next few years.

Welding a Four-Story Commercial Building

Design and Erection Utilize Possibilities of Welding—Continuous Beams and Single-Story Columns—Alternate Columns in Storefront Removable

THE FOUR-STORY Upper Carnegie Building, which recently has been completed in Cleveland, is believed to be the first commercial structure that has been designed for and erected by arc welding. The use of welding instead of riveting necessitated changes both in the design of the steel and in the methods of erection. The main change in the design was the utilization of long continuous beams in conjunction with columns of single-story heights as contrasted to the usual multi-story columns and short beams. This arrangement is indicated diagrammatically in Fig. 3. Inasmuch as no rivets or bolts were used to hold any parts of the structure together during construction, an ingenious system of erection bracing was devised.

As shown in Fig. 3, the building is 60x119 ft. in plan.

FIG. 1—UPPER CARNEGIE BUILDING, CLEVELAND
An electrically welded steel frame inclosed in brick and limestone.

The ground floor is divided for storerooms and the three upper stories for offices. The continuous beams run lengthwise in the building and are spliced only at the center. The framing across the width of the building consists of open-web bar joists welded to the continuous beams and given lateral stiffness by means of wire bridging and two $\frac{5}{8}$-in. diameter rods, equally spaced in each bay, laid across the bottom chords and tack welded to the joists. Because the two upper floors of this building were designed for doctors and dentists and there was no large vertical pipe shaft provided in the building, there are a large number of pipes coming down alongside the columns. If the customary struts had been provided between the columns on the north-south center lines of columns, it would have been necessary to break all these pipes around the struts or greatly enlarge the size of the furring around the columns in order to conceal these vertical pipes. For this reason it was decided to run the pipes vertically along either the north or the south face of the columns. This required the joist to straddle the north-south center lines of columns. In order to make the joist on either side of the columns strong enough to act as struts as well as to carry partitions, a 4x$\frac{1}{4}$-in. plate was welded to the top side of the top flange of the bar joists adjacent to the columns.

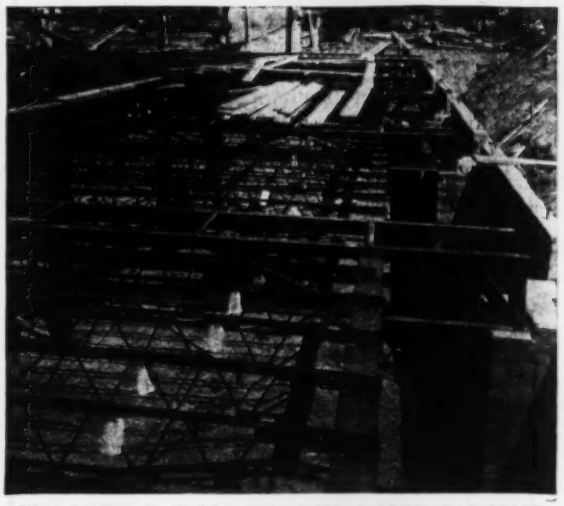


FIG. 2—FIRST FLOOR FRAMING, UPPER CARNEGIE BUILDING, CLEVELAND
Heavy lattice girders of welded angles in the front bay support the partition walls and the store bulkhead girders. Note method of welding bar joists to beams.

The floors in the building consist of a 2-in. concrete slab and a 1$\frac{1}{2}$-in. finish, reinforced with $\frac{3}{8}$-in. rib lath weighing 3.4 lb. per square foot and $\frac{3}{4}$-in. diameter rods, spaced 24 in. on centers. A light galvanized-wire mesh was embedded in the 1$\frac{1}{2}$-in. thick floor finish to minimize the cracks which are bound to happen in a building of this type, due to the development of negative bending over girders.

Welds were $\frac{3}{8}$-in. triangular fillets except the butt welds at the splices of the continuous beams, which were of the double-vee type. All connections were designed with a minimum factor of safety of 4, assuming a working stress for a $\frac{3}{8}$-in. fillet weld of 2,500 lb. per linear inch. Separate detail drawings were made for the shop and field welding. Both of these sets of drawings supplemented the general design drawings. The two sets of welding drawings were required, because there has been no nomenclature developed to distinguish between shop and field welding. The design was based upon requirements of the Cleveland building code, which grants the building commissioner broad enough dis-

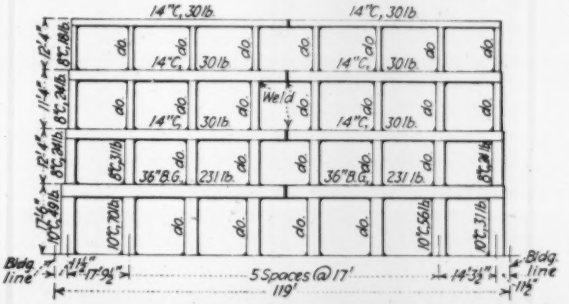


FIG. 3—SKETCH OF FRAMING ARRANGEMENT, FRONT ELEVATION, UPPER CARNEGIE BUILDING
Note that all beams are continuous, being spliced only at the center, and that column weights or sizes change at every floor level.

FIG. 4—WELDING OPERATORS AT WORK ON THE UPPER CARNEGIE BUILDING, CLEVELAND

At the left, a plate stiffener is being attached to the 36-in. rolled-steel girder. The angles and blocks welded to the beam flanges located the flanges and webs of the columns. In the center, the welder is running a bead around the bottom of a column resting on the 36-in. girder. At the right, the welder is splicing the two halves of one of the 120-ft. continuous beams.

cretionary power to warrant his issuing permits when accredited concerns handle the design, fabrication and construction. The inspection of the welds was made by visual examinations on the part of expert welders, one of which was required by the building commissioner.

Provision for Alterations

One of the unusual features of the structure is the provision in the design for the removal of alternate columns in the front of the lower story so that either 17- or 34-ft. storefronts are available. This is made possible by the use of a 36-in. rolled girder beam in the second floor continuous across the front of the building, as shown in Fig. 5. The girder was erected in two 60-ft. lengths and spliced at the center, as were the other continuous beams.

All fabrication was done outdoors at the contractor's fabricating plant. A battery of five motor-generator type welders were used to supply the welding current to five operators. These machines mostly were of 300-amp. capacity, although for some work a 200-amp. welder was used. Numerous features of the welding fabrication are of interest. All columns were milled top and bottom for bearing on base plates or on the flanges of the continuous beams. The basement columns were set upright on their slab base plates and attached by welding a continuous bead along the outside edges of the flanges; a similar procedure was used during erection in attaching the columns to the beams. The majority of the beam stiffeners were made from flat steel plates and were welded between the flanges at the points where the columns joined the beam and directly under the positions of the column flanges. Where the column flanges were to be placed parallel to the webs of the beams,

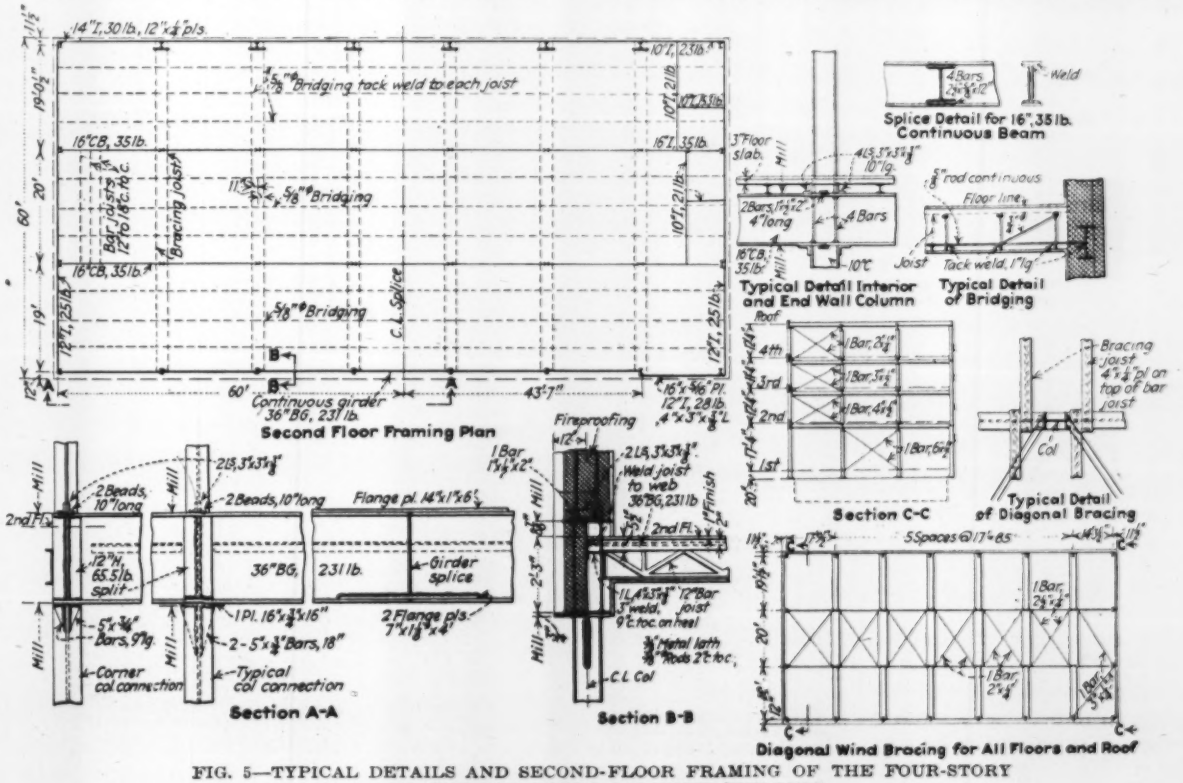

Second Floor Framing Plan
Section A-A
Section B-B
Section C-C
Splice Detail for 16", 35 lb. Continuous Beam
Typical Detail Interior and End Wall Column
Typical Detail of Bridging
Typical Detail of Diagonal Bracing
Diagonal Wind Bracing for All Floors and Roof

FIG. 5—TYPICAL DETAILS AND SECOND-FLOOR FRAMING OF THE FOUR-STORY ARC-WELDED UPPER CARNEGIE BUILDING

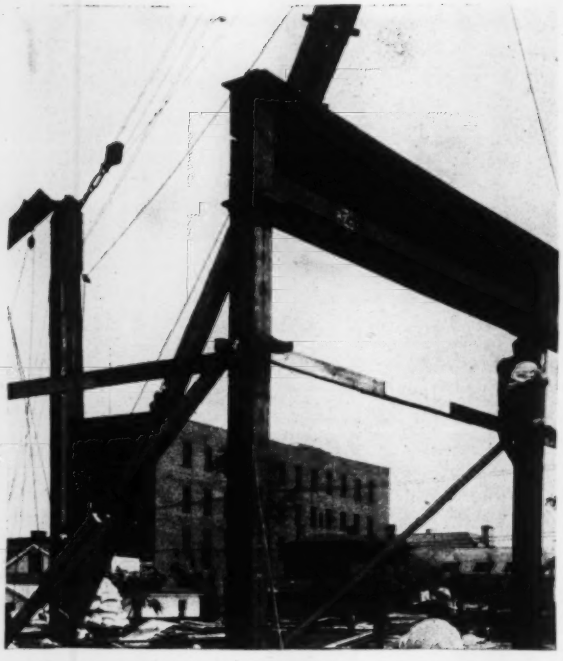


FIG. 6—BRACING SYSTEM USED FOR ERECTION
Inclined and horizontal braces fitted with strap-iron hooks fastened to the bolts of the frame shown around the column. No field bolts were used during erection to hold any of the members of the structure together.

tee stiffeners made by cutting steel H-sections in half were used.

Lattice girders, each made up of two parallel trusses, were used in the front of the building on the first floor, as shown in Fig. 2. These girders, which permit the installation of concealed piping and carry the first-floor partitions and the storefront bulkhead beam, have a span of 18 ft. 1 in. Each truss comprises a top and bottom chord of 4x3x$\frac{5}{16}$-in. angles with web members of 2$\frac{1}{2}$x2x$\frac{1}{4}$-in. angles; the end verticals are 4x$\frac{3}{8}$-in. plates. The two trusses are joined by braces at the panel points and thus form a lattice girder 22 in. wide by 18 in. deep back to back of angles of the top and bolten chord.

A feature of the fabrication which facilitated field erection was the welding of locating angles and blocks to the continuous beams. These, as well as the plate stiffeners, are shown being welded in Fig. 4. The angles located the flanges of the columns and the small blocks fixed the position of the column webs.

The use of continuous beams with single-story columns is the most unusual feature of the building. This arrangement is said to have been a main contributing factor to the saving of about 13 per cent in steel tonnage, which resulted from the use of a welded rather than a riveted design. As shown in Fig. 3, the column weights change at each floor level and at the second floor the column size is reduced from that used in the first story. In other words, each tier of columns was closely designed for the exact loads it had to carry. The column loads are passed through the continuous beams by means of the stiffeners, and because of these and the rigid welded connections of columns to beams, the former approach closely to the rigidity of multi-story columns. Because the columns did not have the continuity of the customary multi-story columns, horizontal diagonal bracing was placed in the middle aisle of each floor and in the roof from end to end of the building, while vertical diagonal bracing was carried down to the ground in each end. Because the building was erected in two sections, temporary vertical diagonal bracing consisting of cables was required in a north-south direction in the middle of the building.

Method of Erection

Erection—All of the continuous beams were erected in two sections, each section being approximately 60 ft. long, and vee-butt welded together, as shown in Fig. 4, on the approximate north-south center line of the building. At these splices reinforcing plates also were welded on top of both the top and bottom flanges only as an added precaution, since theoretically this type of butt weld develops the full section without the use of splice-plates.

The angles which were welded to the upper and lower flanges of the beams during fabrication automatically spaced the columns longitudinally, but since steel bar-joists instead of beams comprised the lateral members of the building, except at the ends of the structure, it was necessary to devise some method to space and brace the columns laterally. Special square frames of wood blocks and long bolts were therefore developed which could be fastened around the columns near their tops to provide a means for connecting timber bracing in both directions. Some special means of connecting this bracing was doubly necessary, since there were no erection bolt holes in the columns. The frames, one of which may be seen in Fig. 6, consisted of two 2x2-in. blocks held on opposite sides of the columns by two long bolts, the bolts and blocks forming the square. These bolts also fastened to the wood blocks four small angles

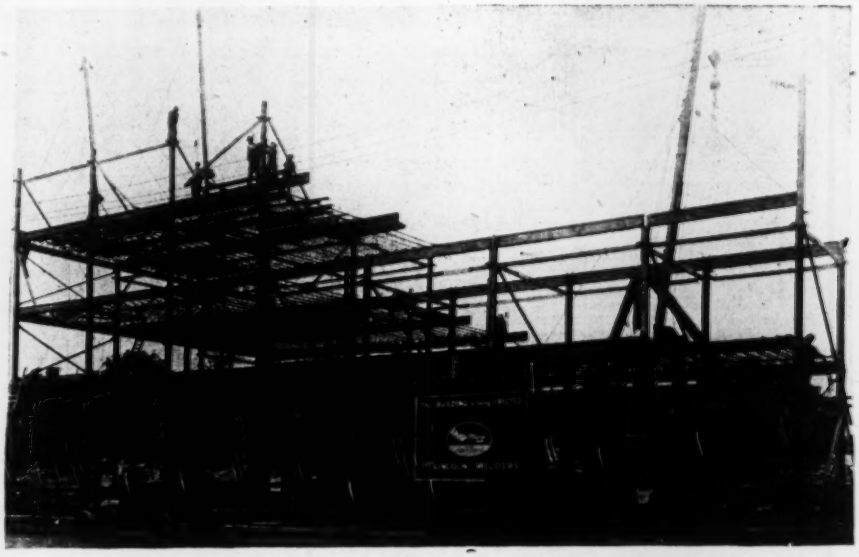


FIG. 7—ERECTING A FOUR-STORY BUILDING BY ARC WELDING
Note workmen setting up bracing system for fourth floor column.

FIG. 8—THE BATTERY OF FIVE VARIABLE-VOLTAGE WELDING SETS WHICH SUPPLIED THE WELDING CURRENT

(Fig. 6), through the outstanding legs of which two other long bolts were inserted. Thus the frame had bolts on all four sides, permitting the horizontal and inclined bracing (2x4 and 4x4 timbers) to hook onto the columns with strap-iron hooks.

In addition to these frames convenient clamps were made to fasten to the upper flanges of the beams or over the joists as anchorages for the lower ends of the inclined bracing. The bracing system may be seen in Fig. 7, where workmen are shown erecting the necessary timbers for supporting one of the fourth-story columns.

The method of erection was to set up one row of columns, each column fitted with one of these bolt-and-block frames. The columns were accurately plumbed and the 4x4-in. inclined timber braces attached. Next the adjoining row of columns was erected and held in position by the horizontal timber braces or spacers, which were cut to fit accurately between the different columns. With these columns erected and braced, the longitudinal beams were hoisted and fastened to the columns by large C-clamps. The angles which had been welded to the beam for the purpose of locating the columns provided a convenient arrangement for clamping the beams and columns together. Before any welding was done the steel bar-joists were placed across the beam. Then the complete panel was welded while the erection crew was placing another unit consisting of beams, columns and joists. With this welding completed, the welding and erection crews exchanged places, the latter proceeding to erect steel above the unit just welded.

The building was designed and built by the Austin Company, Cleveland, Ohio, for the Owners Investment Company, owned by W. J. Austin and associates. Harry E. Stitt is chief engineer of the Austin Company. The structural steel was fabricated in the Austin Company's fabricating plant, the arc welding there and in the field being done by the Lincoln Electric Company, of Cleveland. The Welding Engineering & Construction Company, of Cleveland, was engaged as consultant and welding inspector.

Chlorination Relieves Ponding on Sewage Filter Beds

Chlorine Added to Tank Effluent at Lackawanna, N. Y., Clears Trickling Filters, Pipe and Nozzles—Night Use Advised

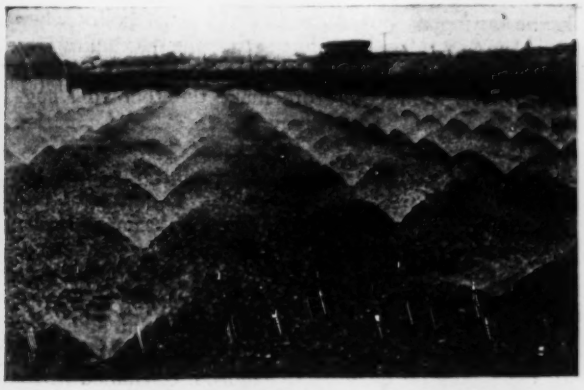
By Frederick K. Wing and Roger C. Williams
Consulting Engineer and Consulting Chemist, respectively, Rochester, N. Y.

During the spring of 1928 trouble was experienced at the sewage-works of Lackawanna, N. Y., due to a growth of slime and an accumulation of the solids on the sprinkling filter beds. This slime has been shown responsible for extensive ponding of the filters and also for the deposition inside of the pipes and spray heads, which resulted in friction and caused the sprays to become very feeble. The writers were called into consultation, and following investigation and laboratory tests recommended the use of chlorine, which has been entirely satisfactory in remedying the troubles, as is indicated by the accompanying illustrations.

It was found upon examination that the slime consisted of gelatinous vegetable growth, somewhat similar to that which forms on the stones of a slowly moving polluted brook. This slime caught and held grease and particles of scum, which came from the Imhoff tanks, and also dust from a near-by road and cinders from the railroad near by. The co-operation of the Chlorine Institute and of Wallace & Tiernan Company, Inc., was obtained. In view of the extent of the ponding they considered the use of chlorine for the purpose of cleaning the filter beds as an experiment and therefore agreed to the loan of a solution feed chlorinator in order to secure a very exacting test of the process, which had proved successful elsewhere but under less severe conditions.

The Lackawanna plant is built in duplicate throughout, with two Imhoff tanks, two dosing tanks and two

PONDED SEWAGE FILTER AT LACKAWANNA, N. Y.
View taken June 10, 1928, before chlorination.



LACKAWANNA SEWAGE FILTER AFTER CHLORINATION

sprinkling filter beds. A small shed was built to house the chlorinator over one of the dosing tanks, and connections were made so that the chlorine solution could be fed directly into the dosing tank. Thus the sewage in the dosing tank was charged with chlorine just prior to discharge to one of the filters.

In the early stages of the experiment the chlorinator was set to deliver 25 p.p.m. of chlorine based on the average 24-hour flow to the west filter. Because of the septic state of the Imhoff effluent residual chlorine could not be maintained sufficiently high in the discharge to the filters. Beginning June 30 and for five days thereafter 250 lb. of chlorine per day was applied during the 24-hour periods of application and thereby an average dosage of 32 p.p.m. was secured, which insured the presence of 0.5 to possibly 5 p.p.m. (maximum) in the applied sewage. The well-known effect of chlorine on biological growths quickly began and resulted in disintegration of the slime, which sloughed off and was washed out of the filter. The same treatment was applied to the east filter with like gratifying results, as shown by the accompanying views of the beds before and after chlorine application. After the treatment the stones looked clean, and new and moreover the header pipes and spray nozzles were cleaned as a result of chlorination and the sprays again became vigorous and full, as may be seen in the illustration.

In all 1,250 lb. of chlorine was applied to each filter having a surface area of 0.68 acre, or at a cost per acre of $110.29 with chlorine at 6c. per lb. Our experience indicates, however, that chlorine application to the night flow only would have materially reduced the expense of the treatment.

Toward the end of the treatment orthotolidine tests were made on the effluent from the bed, but no residual chlorine was indicated. This showed that all the free chlorine in the water being sprayed on the bed was used up in attacking the organic material collected on the stones of the bed.

Inasmuch as it is chiefly the free or residual chlorine in the water sprayed on the beds which does the work of cleaning, the higher the concentration of the free or residual chlorine (within limits) the quicker the action. If it were possible to chlorinate pure water and spray it on the beds, practically all the chlorine used would be present as free chlorine. Because of the high biochemical oxygen demand of the effluent to the dosing tanks, however, a great deal of the chlorine used is absorbed before any residual chlorine is produced. It is, therefore, advisable if possible to decrease the flow of sewage to the filter being treated with chlorine and to apply chlorine during only that portion of the 24 hours when the sewage is weakest and thus secure the maximum free or residual chlorine in the sewage with the least chlorine applied. We would therefore make the following suggestions to others who contemplate the use of chlorine for this purpose:

(1) Do the chlorinating at night only, for then the sewage has its lowest biochemical oxygen demand and is least in volume. (2) Add sufficient chlorine to insure residual chlorine values of 3 to 5 p.p.m. in the sewage at the nozzles. (3) If possible reduce the flow of sewage to the filter being chlorinated by diverting all except sufficient flow to insure against failure of the siphon to function properly. This will insure maximum benefits with the minimum quantity of chlorine consumed in the process. (4) Repeat each night until the beds are cleaned. (5) Following the initial treatment, succeeding treatments should not be nearly so costly and should be rather infrequent.

We consider the results obtained at Lackawanna most successful and are publishing them in the hope that others may profit from our experience.

Features of New York City's New Municipal Airport

Floyd Bennett Field, on Jamaica Bay, Will Include Facilities for Both Land Planes and Seaplanes

THE NEW MUNICIPAL AIRPORT in New York City, recently named Floyd Bennett Field, located on Jamaica Bay about 12½ miles east of the Pennsylvania station, is under construction and represents the first venture of the kind in which the city of New York has taken part. Some of the features of the new airport were outlined recently by T. W. Keller, chief engineer, Department of Docks, City of New York, before the Brooklyn Engineers' Club. The following information is taken from Mr. Keller's talk.—EDITOR.

THE MUNICIPAL airport for New York City being built by the Department of Docks on Barren Island in Jamaica Bay embraces about 387 acres and includes all facilities for both land planes and seaplanes. It is contemplated that the final development will contain 814 acres.

The initial construction is to provide hangar space for about 100 planes and parking space for about 3,000 automobiles. Two concrete runways are to be provided, one extending 3,110 ft. from southeast to northwest and the other 4,000 ft. from southwest to northeast. Each of these runways will be 50 ft. wide, planned for take-off purposes only. They are to be constructed in accordance with highway specifications.

The top grade of the entire field is to be constructed on sand pumped in from Jamaica Bay. It will be approximately 16 ft. above mean low water; to date about 6,000,000 cu.yd. of sand has been pumped into place. The top surface will consist first of a layer of sub-soil with a good clay mixture covered with a top soil suitable for sustaining a growth of thick grass. To eliminate sand blowing onto the field a hedge is being erected on the northwesterly side, from which direction the strongest winds blow.

A feature of the airport will be a seaplane base located in the Jamaica Bay channel and comprising a paved bulkhead area 400x800 ft. and including 48,000 sq.ft. of hangar space. There will also be a special waiting room, ticket offices, etc., for the seaplane base. North of the bulkhead area there will be provided a beach 1,200 ft. long on which planes that do not wish to come up to the hangars may be beached and the passengers taken ashore or embarked by means of a gangplank.

A concrete ramp running from the 16-ft. level of the field to 5 ft. below low water is included in the plans to assist seaplanes or amphibians in entering or leaving the water. This ramp will be 100 ft. wide and approximately 260 ft. long.

In the New York City budget for 1929 $2,500,000 has been appropriated for the development of Floyd Bennett Field. Before the end of the current year the airport should be well along toward completion.

Machine-Finished Asphalt Paving Adopted in California

Machines Used Exclusively in 1928—Speed of Hand Method Doubled—Cost Less and Smoothness Greater

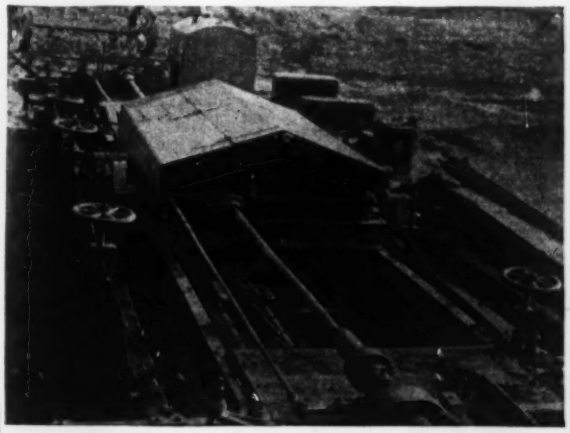
By C. S. Pope

Construction Engineer Division of Highways, California Department of Public Works, Sacramento, Calif.

ALL ASPHALTIC concrete pavement laid during 1928 on California state highways was spread, raked and finished by mechanical means. This method of finishing, in the opinion of the author, marks the greatest advance of twenty years in asphalt pavement construction and opens up a new era in its use limited only by the developing of surface stability suitable for modern traffic.

Exclusive mechanical finishing for asphalt paving was adopted by the department in 1927 after extensive experiments, described in *Engineering News-Record*, Dec. 1, 1927, p. 869, had proved the method a success. The year's operations indicate: (1) greater increase in surface smoothness, which was the primary objective in developing mechanical means; (2) uniform smoothness with a decrease in the amount of skilled labor; (3) twice the tonnage which the paving crew can handle by hand; (4) less inspection than for hand raking; (5) easier rolling due to more uniform surface preparation; (6) no creeping during rolling, but direct settlement; (7) a regular arrangement of aggregate, producing a surface less inclined to displacement; (8) a practically non-skid surface at the time of completion and for many months thereafter; (9) cost reduction due to greater plant output, more rapid laying, decreased rolling cost and less overhead and carrying charges.

Asphaltic concrete is used chiefly on the state highway system to widen and improve old 15-ft. portland cement concrete highways. Shoulders 2½ ft. x 4 in. are laid first to provide a 20-ft. base 4 in. thick. A leveling course of asphaltic concrete is then laid and rolled on this base to take out the 2¾-in. crown of the old pavement. The surface course, about 2 in. thick, is then spread, rolled to a true grade with a 1½-in. crown in 20 ft. and finished with asphalt-coated stone chips. This surface course is an asphaltic concrete composed of crushed stone, sand and limestone dust and asphaltic cement.

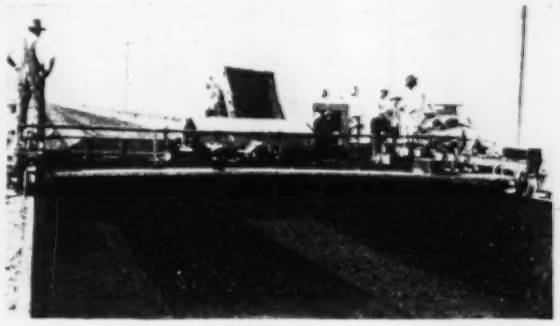


CONCRETE FINISHER ADAPTED FOR WORKING ASPHALT
The added features consist of two rakes placed between two vertical metal screeds.

Mixtures and Stability Test—A typical surface mixture grading by separate screen tests of aggregate is:

Screen Size	Per Cent Passing	Screen Size	Per Cent Passing
1½-in.	90 to 100	No. 40	23 to 27
½-in.	60 to 75	No. 80	15 to 20
No. 3	40 to 55	No. 200	7 to 11
No. 10	28 to 36	Asphaltic cement	4.5 to 6.5

The material passing the No. 200 screen is required to be 66 per cent limestone dust, as this has proved superior to all other filler materials. Relative specific gravity, the quotient of the field specimen specific gravity divided by the theoretical specific gravity of the combined mineral aggregate and asphalt, is obtained daily from one or two compressed road surfaces.



MACHINE FINISHING A 20-FT. ASPHALT PAVEMENT
This machine is screeding base course without rakes.

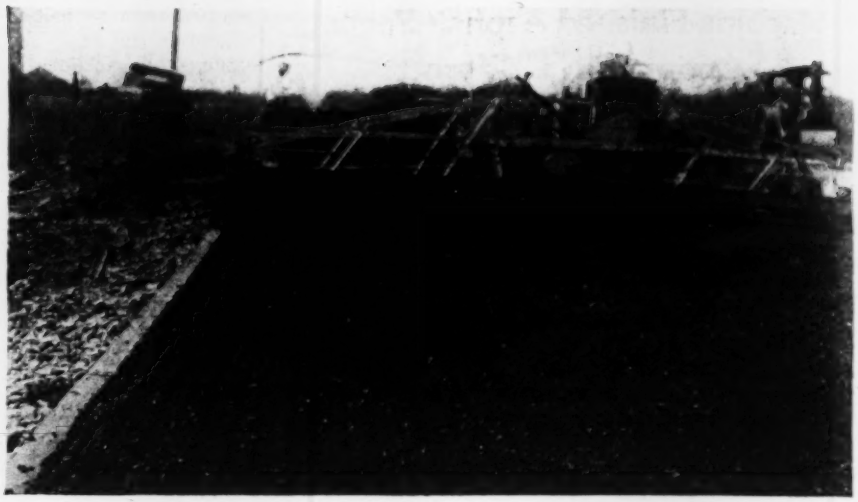
Mortar stability is obtained on the portion of the mixture passing the 10-mesh screen, including the asphaltic cement, by the method suggested by Hubbard and Field. A stability in excess of 2,500 lb. has been maintained by proper selection of sand and percentage of filler, whereas pavements laid in former years showed stability as low as 1,600 lb. The stability of the complete mix, including coarse aggregate, is reported as having been obtained with reliable and concordant results by the method and machinery of Abson and Skidmore, but no test has yet been made on the work with this method. Stability of either mortar or complete mixture is usually defined as its ability to resist shear or displacement of the particles in relation to one another. The resistance is measured in pounds pressure required to distort standard specimens.

Paving Procedure—The steps in mechanical paving are practically the same as in the hand method except for the machine spreading and raking. Strong, well-staked forms are essential; 3-in. planks extending the full depth of the pavement and supported at 4-ft. intervals on heavy stakes driven to subgrade are used with as many side stakes as are necessary to prevent spreading. The usual methods are employed in preparing the foundation and constructing the borders. The mixture is then brought to the job in pneumatic-tired trucks, dumped at a temperature of about 280 deg. F. into spreader boxes and distributed roughly for the raking machines.

Two standard-type concrete-finishing machines were adapted to asphalt finishing and used successfully. Each uses two vertical plate screeds, with a double row of teeth between them to assist the rear screed in distributing the material. Speed of advance under load is 8 to 10 ft. per minute for either machine depending on the

temperature of the mixture. During advance the front screed is kept well loaded, while the one to the rear carries before it a slight wave of asphaltic mixture. Experience showed that the rakes might be eliminated for the base or leveling course, striking off the asphalt by means of the screeds only, but in the opinion of the author raking is very essential in producing the best surface finish.

The action of the rake teeth arranges the material to form a wearing surface and the formation of furrows aids in proper compacting so that the asphalt does not travel or shove in front of the roller. Following the first rolling of the surface, 4 to 9 lb. of ¼-in. to ⅝-in. asphalt-coated rock screenings per square yard are cast on the surface and rolled in to form a non-skid finish. Surface smoothness is obtained by using steel strips ⅝ in. thick 3 in. wide and 10 ft. long laid on the side forms. These strips also allow the proper excess thickness for roller compression and are taken up and moved forward as the machine advances.



FURROWED SURFACE LEFT BY RAKES
This furrowed condition aids compaction and produces non-skid surface.

Speed and Costs—Mechanical spreading and raking is cheaper than hand labor, and speeding up the entire laying process also tends to reduce the plant costs. Data from two state contract jobs several miles long show the actual cost per ton as applied solely to machine spreading and raking to be approximately 14c. to 20c., according to the accompanying table. Hand-labor costs for spreading and raking, as indicated by several contracts using efficient and economical organizations, is about 25c. per ton.

Comparison of laying speeds greatly favors the machine method. A record of 820 tons laid by machine in one day on two strips of 20-ft. paving has never been approached by hand labor on California highways nor is it considered feasible to lay such a tonnage by hand. It is safe to predict that runs of 1,000 tons per day will not be unusual for machine spreading and raking.

Surface smoothness is also improved by the use of mechanical finishing. The usual smoothness of a good, hand-laid asphaltic street surface is about 25 in. per mile as determined by the roughometer (vialog) attached to cars equipped with cord tires. The reading per mile may be reduced to about 18 in. with the most careful hand raking. Machine raking produces a smoothness of 12 to 14 in. and careful rolling will reduce the roughometer reading per mile to less than 10 in., which is as smooth as any paved surface except the most carefully finished concrete.

COST OF MACHINE SPREADING AND RAKING ASPHALTIC CONCRETE

Labor	Contract A 20-ft. paving	Contract B 30-ft. paving
Foreman	$8.00	$8.00
Machine operator	8.00	8.00
Raker	5.50	8.00
Raker	.....	7.00
Dumpman	.....	6.00
Two railmen	8.00	.....
Railman	.....	6.00
Seven shovelers	28.00	.....
Five shovelers	.....	25.00
Total daily labor cost	$57.00	$68.00
Machine:		
Gasoline and oil	$1.20	$1.20
Estimated depreciation	15.00	18.00
Total daily machine cost	$16.20	$19.20
Total daily cost (machine and labor)	$73.70	$87.20
Tons laid per day (job average)	361.40	574.00
Cost per ton to spread and rake by machine	$0.204	$0.152

Note: During the best ten-day period on contract A the average was 513.1 tons per day, or 14.3c. per ton.

Laboratory Tests of Floor Materials

Results of a number of tests to determine the physical characteristics of various commonly used flooring materials have been published in the *Journal* of the American Ceramic Society. The tests were made by Carl H. Geister, industrial fellow at the Mellon Institute of Industrial Research, University of Pittsburgh. Apparatus was devised which, when applied to samples of the various materials, yielded comparable results as regards resistance to abrasion, heat and indentation, and also resistance to the absorption of water. Results of the tests are given in the following table:

Material	Abrasion Test, Percentage Loss	Absorption Test, Percentage Gain	Heat Test, Temperatures, Deg. C. Affected and Failed	Indentation Test, Percentage Depth Depression
Vitreous tiles	4.5	0.0	900+	0.0
Semi-vitreous tiles	8.6	5.1	900+	0.0
Faience tiles	15.3	10.6	900+	0.0
Portland cements	16.8	9.6	150–700	0.0
Oxychloride cements	60.4	13.1	100–500	0.0
Linoleums	72.9	6.2	60–300	13.6
Corks	44.2	25.5	100–300	26.7
Rubbers	19.8	1.1	60–300	4.0
Woods	33.8	66.1	100–300	0.0
Asphaltic compositions	80.1	0.8	70–300	61.9
Marbles	23.3	0.1	400–700	0.0
Terrazzo	16.1	2.6	150–600	0.0
Slate	58.2	0.3	300–600	0.0

The test for abrasion was made on a special machine developed by the experimenter which brought to bear upon samples a pressure and scratching effect similar to that of human footsteps. The use of sand imitated the effect of dirt ordinarily found on floors. Tests for indentation were made by means of a 75-lb. load applied for 48 hours through an ordinary 1-in. furniture caster. The absorption test was made in accordance with that prescribed in the Navy Department specifications, while the resistance of heat was evaluated at the temperature at which the sample showed definite signs of deterioration and failure, due either to combustion or decomposition.

Second of a Series of Five Articles

Basic Principles of Concrete-Making

By F. R. McMillan

Director of Research, Portland Cement Association, Chicago

II—Strength and Watertightness—Supporting Data

Factors Affecting the Water-Cement Ratio Strength Relation: Size, Grading, and Type of Aggregate, Curing Conditions, Characteristics of Cement—Experimental Data on Watertightness—Effect of Water-Cement Ratio, Curing Conditions, Characteristics of the Cement—Other Properties of Concrete

IN THE first article of this series there was presented a résumé of the basic principles of concrete mixtures in which it was shown how the properties of concrete (plastic concrete) must in the main be dependent on the properties of the hardened cement paste. The properties of the hardened paste, in turn, it was pointed out, were dependent on these three factors:

1. Characteristics of the cement.
2. The proportion of water to cement—the water-cement ratio.
3. Extent to which chemical reactions of hardening are complete.

In this article data will be submitted showing the soundness of these conclusions as regards compressive strength, watertightness and other properties of concrete.

Emphasis was placed in the first article on the need for a plastic consistency, as the dry, stiff mixes are incapable of proper placement and the thin, watery mixes result in segregation. This precaution is of special importance in the matter of watertightness in a concrete structure. If the concrete is so placed that the entire space between the aggregate particles is not filled with the paste, watertightness need not be expected, regardless of the quality of the hardened paste. Likewise, if the consistency of the mixture is such that segregation takes place, either in placing or through settlement after being in place, differences will exist in the watertightness of various parts of the structure due to this segregation.

Plastic consistency is also important if the laws of strength developed herein are to apply. All the strength data submitted are limited to those mixtures which are capable of being properly placed and which remain homogeneous when once in the forms.

Water-Cement Ratio Strength Relation

Since Abrams first pointed out the general relationship between the quantity of mixing water and the compressive strength of concrete there have been many investigations further substantiating his broad conclusions. These further studies have also served to fix more definitely the limits within which the Abrams law of strength may be expected to apply and to establish the reasons for such limitations. The accompanying Figs. 2 to 10 show the water-cement ratio strength relation for a wide variety of materials and conditions. These have been

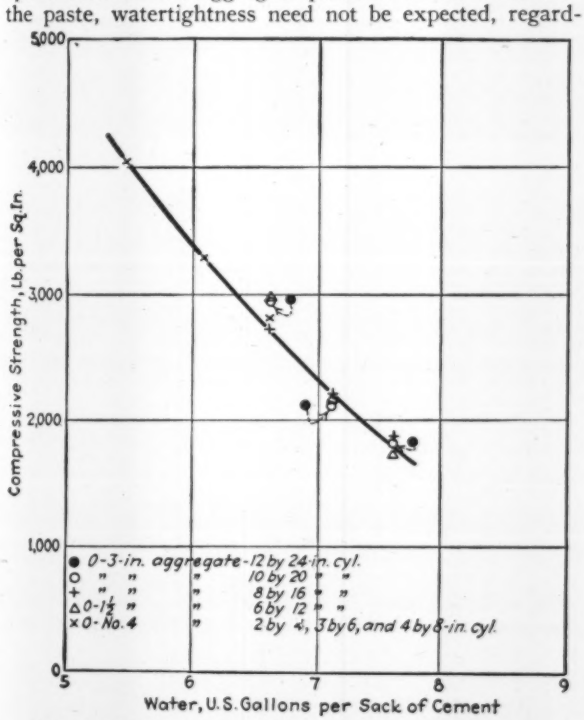

Compressive Strength, Lb. per Sq. In.
5,000
4,000
3,000
2,000
1,000
0
5
6
7
8
9
Water, U.S. Gallons per Sack of Cement
● 0-3-in. aggregate-12 by 24-in. cyl.
○ " " " 10 by 20 " "
+ " " " 8 by 16 " "
△ 0-1½ " " 6 by 12 " "
× 0-No. 4 " 2 by 4, 3 by 6, and 4 by 8-in. cyl.

Fig. 2—Mix variable; consistency variable; moist cured; age at test 14 days; slump 6 to 10 in.

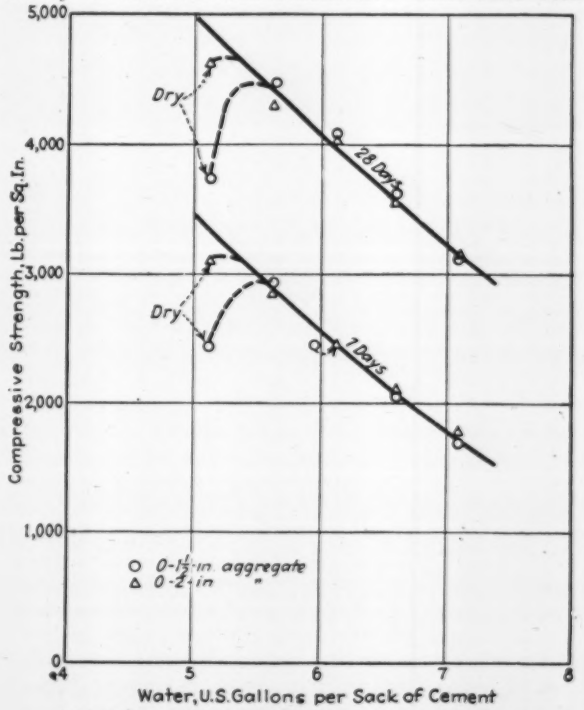


Fig. 3—Mix 1 : 2.45 : 4 by weight; moist cured; age at test 7 and 28 days.

FIGS. 2 AND 3—EFFECT OF SIZE OF AGGREGATE ON THE WATER-CEMENT RATIO STRENGTH RELATION

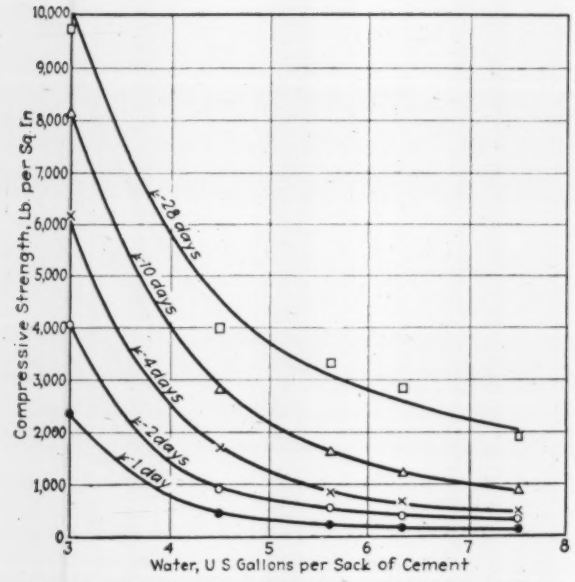


FIG. 4—WATER-CEMENT RATIO STRENGTH RELATION FOR PASTES ONLY

2x4-in. cylinder molds sealed to prevent loss of water; neat cement pastes, moist cured.

specially selected to show the effect of the principal factors which have been found to influence this relationship.

A number of tests have been reported from time to time in which variations in the position of the water-cement ratio strength curves for different materials or conditions have been somewhat greater than indicated in the accompanying figures. In many cases, however, these discrepancies have been due to neglect of certain important factors. One of these is the direct loss of water from the mix through absorption, evaporation or leakage from the forms. Another is the change in character of the mix, due to segregation in the mold. Failure to provide for these properly must naturally affect the results. Still another factor is the use of mixes that are too stiff or harsh to place properly. The importance of this has already been pointed out.

Effect of Size of Aggregate—For ordinary size ranges, size of aggregate has no appreciable effect on the strength of concrete of a given water-cement ratio. This is shown by Figs. 2, 3 and 4. Fig. 2 shows the results of tests of concretes in which the maximum size of the aggregate varied from ¼ to 3 in. In this the same curve between strength and water quantity fits the data for all sizes of aggregate. Other tests bearing on this factor have been complicated by the effect of size of specimen with respect to size of aggregate particles. The tests in the research laboratory of the Portland Cement Association have shown that when the specimen diameter is less than about four times the maximum particle size there is a falling off in strength. To eliminate this variable, the tests in Fig. 2 were made on specimens up to 12 in. in diameter. This large size necessitated making the tests at fourteen days.

In Fig. 2, attention should be directed to the points representing the mortar specimens (sand graded from 0-No. 4). In these specimens considerable water segregated from the mass and collected at the top. This water was carefully drained off and measured and the true water-cement ratio for the remaining water was calculated. It is this corrected water ratio that is plotted. The perfect continuity in the curve for the three different sizes of aggregate shows the basic character of the water-cement ratio strength relation, when the water ratio is based on the actual water in the concrete as it is finally consolidated in the forms.

Fig. 3 shows a comparison of aggregates of 1½ and 2 in. maximum size. The points for the two sizes fall closely along the same curve, indicating that size of aggregate does not influence the position of the water-cement ratio strength curve. This is true for both 7- and 28-day tests. In Fig. 3 can be seen the effect of non-workability on the strength. The dry mixes at the extreme left fall somewhat below the curve. These tests were for a constant mix, so that changes in water content changed the consistency.

Fig. 4 shows the water-cement ratio strength curve for neat cement pastes. These curves are similar in character and position to those for corresponding ages in the other figures presented, showing that whether aggregates are used or not the water-cement ratio governs the strength. In these tests the molds were sealed to prevent leakage. For the wetter mixes there was some accumulation of water at the top of the specimens as in the mortar specimens of Fig. 2. In this series of tests, however, no correction was made for this amount of water. The effect of such a correction in the curves of Fig. 4 would be to move the points for the wettest mixes somewhat to the left and the next point or two slightly in the same direction.

From the data in Figs. 2 to 4 it is seen that the size of the aggregate is not an important factor in the water-

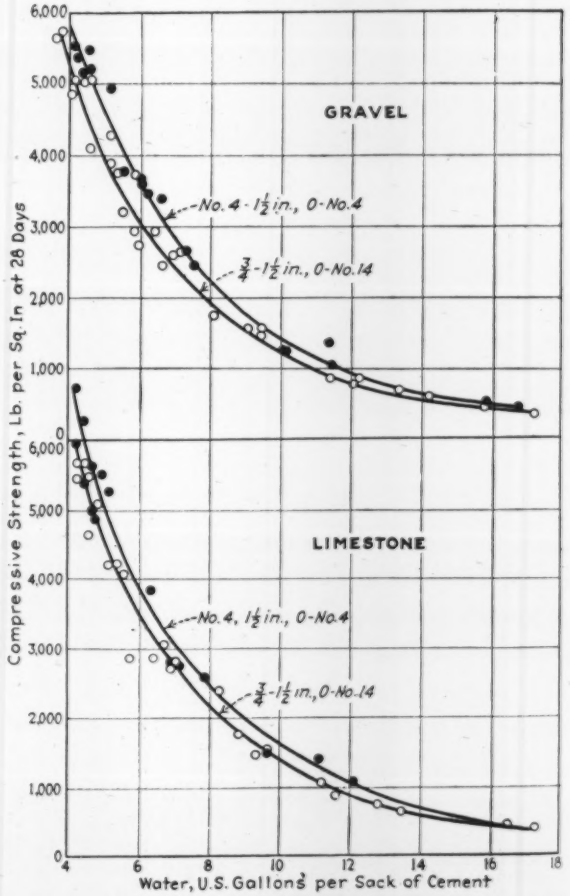


FIG. 5—EFFECT OF GRADING ON WATER-CEMENT RATIO STRENGTH RELATION

Mix 1 : 3, 1 : 5, 1 : 7; three consistencies for each mix.

cement ratio strength relation, provided the tests are conducted with due regard for the other variables and the true water-cement ratio of the concrete in place is considered.

Effect of Grading of Aggregate—The grading of the aggregate has much less effect on the water-cement ratio strength relation than is commonly believed. Too often tests have been made in which non-workability or segregation have been ignored. The small effect of grading is well brought out in Fig. 5, which shows the maximum range in position of the water-cement ratio curve for very wide differences in grading of the aggregates.

The upper curves in Fig. 5 are for coarse aggregates of gravel and the lower curves for limestone. For both coarse aggregates, two separate gradings were used—No. 4-1½ in. and ¾-1½ in. Sands of two gradings were used in both cases, 0-No. 4 and 0-No. 14. Each sand was combined with each coarse aggregate in a number of ratios ranging from all sand to combinations in which the coarse aggregate proportion was the largest that could be used and obtain proper placement. Each aggregate combination was used in three mixes, 1-3, 1-5 and 1-7 (cement to mixed aggregate by volume), and each mix was carried through three consistencies. Only workable mixtures have been included in the figure. It will be recognized that for aggregates of this size the range in gradings is quite extensive.

In plotting the data in Fig. 5, only the highest and lowest water ratio curves of the entire set of data are shown for each aggregate. The curves for all the other combinations in both the limestone and gravel concretes fall within the area between the high and low curves shown. It is of interest to note that in both cases the grading showing the lowest position for the water-cement ratio curve is the one with the largest gap in the size distribution. The total range in position of the curves is quite small considering the actual differences in gradings represented.

Effect of Type of Aggregate—Differences in the water-cement ratio strength relation for aggregates of different types have frequently been brought out. In tests of this factor it is important to take into consideration the differences in absorption between the different materials or else use aggregates which have first been saturated and then brought to the surface-dry condition before using. With this correction the differences between different aggregates ordinarily become of minor importance.

Fig. 6 shows the results of a group of tests in which aggregates of different types were used. For these aggregates the greatest difference is seen to be quite small, and for most of the materials the difference is negligible. Such differences as do exist in the harder materials are as likely to be due to differences in shape and surface characteristics as to strength or mineral structure. Naturally, materials which are structurally weak or friable cannot be expected to give the same strength as the structurally sound materials. In all the discussions involving the strength of concrete in this series it is presumed that only materials satisfactory in these regards will be used. As will be brought out later, the differences between different types of materials are more pronounced in their effect on transverse and tensile strength than on compressive, the largest variations occurring for those cases where the bond or tensile strength is low.

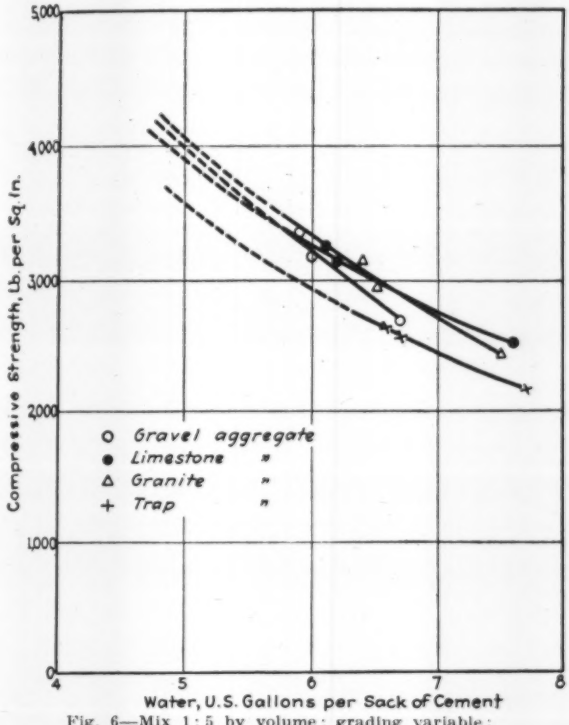


Fig. 6—Mix 1:5 by volume; grading variable; moist cured; age at test, 28 days.

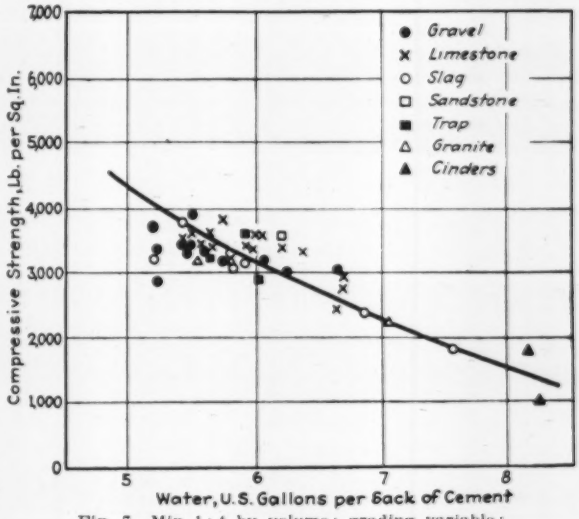


Fig. 7—Mix 1:4 by volume; grading variable; moist cured; age at test, 28 days.

FIGS. 6 AND 7—EFFECT OF TYPE OF AGGREGATE ON THE WATER-CEMENT RATIO STRENGTH RELATION

Fig. 7 shows another group of tests using coarse aggregate of different types, in which a single curve interprets quite well the relation between strength and water-cement ratio for the different materials. In this group of tests there was also some difference in grading, which is probably responsible for some of the spread in the points.

Fig. 5, which illustrates the effect of grading, also provides a comparison of two different coarse aggregates. In this figure it will be noted that the position of the water ratio curve for the gravel was practically identical with that for the limestone.

Effect of Curing Condition and Age—In the first article considerable attention was given to the possibility of building up the internal structure of concrete through continued curing, and some data were presented showing

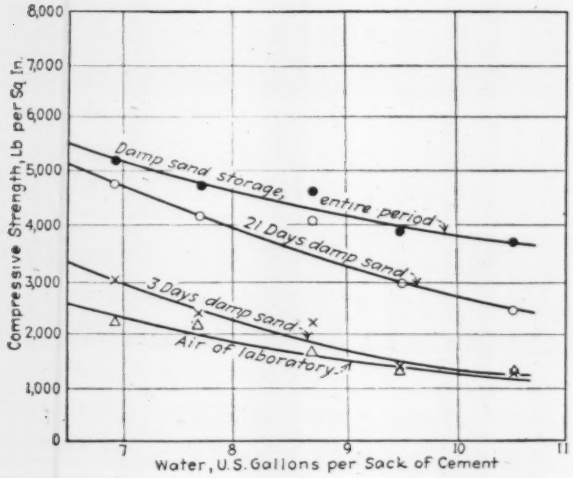


Fig. 8—Mix 1:4 by volume; gravel concrete; age at test, four months.

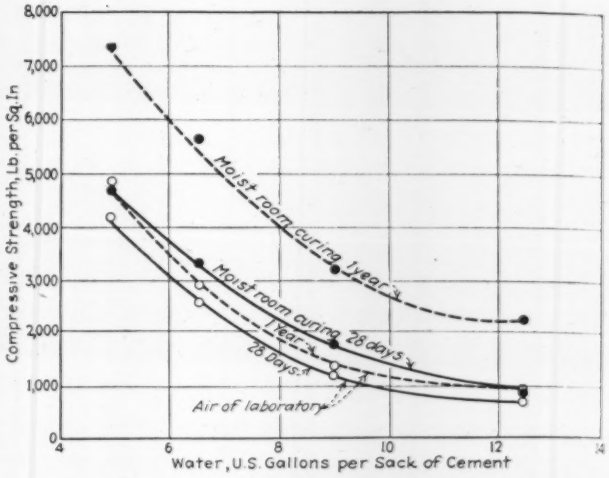


Fig. 9—Mix variable, ranging from 1:3½ to 1:9; consistency constant; slump 3 to 4 in.

FIGS. 8 AND 9—EFFECT OF CURING CONDITION ON THE WATER-CEMENT RATIO STRENGTH RELATION

the amount of water that could become a permanent part of the solid mass. The fact that curing increases the strength of concrete is generally recognized, but it is not likely that the full possibilities for improvement through additional curing are widely realized. The data presented here will show something of these possibilities and bring out the minor significance of the other variables discussed when considered in comparison with this major factor.

Fig. 8 shows the water-cement ratio strength relation for concrete at the age of four months for different periods of moist curing. Comparing the curves for 3 and 21 days' moist curing, it will be seen that the extra eighteen days in moist sand adds from 1,200 to 1,800 lb. per sq.in. to the strength of the concrete at four months.

The comparison between the 21 days' moist curing and the curing damp for the entire period cannot be fairly made from this figure, as the difference in moisture condition at time of test is involved. The curve representing damp sand storage for the entire four months would be still higher if the specimen had been dried before testing. This difference in strength due to moisture condition at time of test is generally recognized.

Fig. 9 gives another comparison of the effect of curing. As in Fig. 8, if the moist-cured specimens had been dried before testing, the comparison would have shown a still greater advantage for the moist curing. This would be true for both the 28-day and one-year tests.

In these curves it is seen also how the two factors of water content and degree of chemical combination are interrelated in the development of strength in the cement paste. In shape, the curves are generally similar to those from the other tests, each degree of curing providing its own curve. Thus, changing either the water ratio or degree of curing does not alter the importance of the other.

From a study of the data in Figs. 8 and 9 it is seen how important is the matter of curing as compared with the small differences shown for the other variables which have been considered. As will be brought out at other points in this series, *these data show the futility of too fine distinctions in these lesser variables when such important differences are possible through additional moist curing.*

As brought out in Article I, age and curing cannot be separated. Increase in age merely provides for further chemical combinations if the conditions are favorable for continued reaction. This is illustrated in Fig. 10, which shows the effect of age on the water-cement ratio strength relation for moist-cured concrete. There are two points of special interest concerning the curves in this figure. First, the similarity in the curves representing the water-cement ratio strength relation for the various ages; and second, the significance of variations in mix, consistency, size of aggregate, and grading. On this latter point it will be noted that for each age the water-cement ratio fixes the strength, regardless of the cement content, consistency, or aggregate characteristics. This point, which has been brought out in the discussion of the other figures, emphasizes the fundamental character of the water-cement ratio strength law.

The similarity of the curves for different ages is significant in reference to the comment frequently made that the mixes of high water ratio eventually gain strength more rapidly than the mixes with the lower water content. That this is not the case can be seen from the fact that these curves continue to diverge as the water-cement ratio is reduced.

Effect of Character of the Cement—Of an importance comparable with differences in curing is the effect of the characteristics of the cement on the water-cement

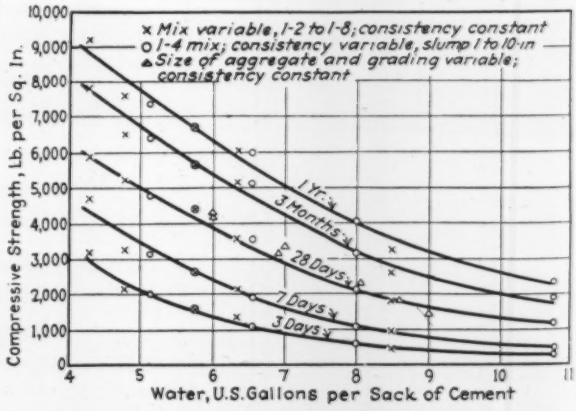


FIG. 10—EFFECT OF AGE ON THE WATER-CEMENT RATIO STRENGTH RELATION
Moist room curing.

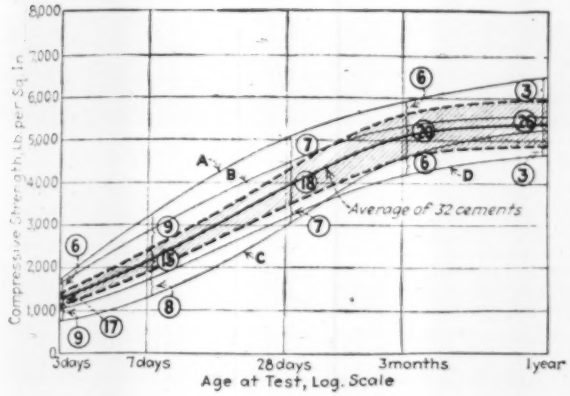


FIG. 11—AGE-STRENGTH RELATION FOR 32 CEMENTS
Mix 1 : 2.4 : 3.6 by weight; water-cement ratio 6.2 gal. per sack; cured in moist room.

ratio strength relation. While all cements behave similarly, they do not all gain their strength at the same rate. This is clearly brought out in Fig. 11, which shows tests of concrete made from 32 brands of cement which were studied by committee C-1 of the American Society for Testing Materials and reported at the meeting of the society in 1928. These curves are based on the tests made in the Portland Cement Association laboratory, which was one of the 47 participating laboratories. In this diagram, which represents age-strength relation, are shown two of the highest, two of the lowest and the average of the 32. The shaded area represents a belt 10 per cent above and 10 per cent below the average curve. The numbers in the circles at each of the five ages—3, 7 and 28 days, 3 months and one year—represent the number of cements which fall within the band 10 per cent above or below the average, also the number which fall outside of that band on both sides. This method of plotting has been adopted to avoid the confusion from 32 separate curves.

Some of the curves representing individual cements cross from one belt into another, as in the case of cements *B* and *C*; others are more or less parallel with the average, as with *A* and *D*. The increase, as the age at test increases, in the number of cements which lie within the inner belt shows a general tendency toward the *B* or *C* type of curve. This indicates that the difference between cements is more a matter of the rate of gain in strength at the different periods than of the potential strength. This group of 32 cements can probably be taken as representative of the American product, as every section of the country was represented in the selection of the samples to be tested. These samples were purchased from dealers in the open market and it is possible that strengths may have been lowered somewhat in the case of some samples by long storage, no attempt having been made to determine the date of manufacture.

In view of the differences in rate of gain in strength, which are greatest at the early ages, it is to be expected that the water-cement ratio strength curves for different cements at 28 days would differ in position. With a given cement, however, the water-cement ratio curve follows the trend of the curves in Figs. 2 to 10, so that the principles of proportioning mixtures are the same, regardless of the characteristics of the cement.

Effect of Quantity of Cement—So far only slight comment has been made regarding the mix or quantity of cement. It has been quite clearly brought out in other discussions of the water-cement ratio strength relation that the quantity of cement and the water ratio are interdependent factors, a change in the mix being reflected in the strength through the change in water ratio. It is only necessary to emphasize the point here because a clear appreciation of this interdependence is essential to an understanding of the principles of proportioning. The fact that the relation of strength to water ratio remains constant, regardless of change in consistency or a change in mix, shows that for given materials and condition of curing it is not the amount of cement but the proportion of cement and water that determines the strength Figs. 5 and 10 are typical of many tests which show that the quantity of cement affects the strength only as it affects the quantity of water necessary to give the required consistency.

Experimental Data on Watertightness

Effect of Water-Cement Ratio—Unfortunately experimental data on the permeability of concrete are rather limited, and many of those available cannot be analyzed in the manner applied to the strength data. One of the most exhaustive series of tests of permeability is that made at the University of Wisconsin by Withey and Wiepking. (See Bull. 1245, Permeability Tests on Broken Stone Concrete, by Withey and Wiepking, University of Wisconsin, Engineering Series, Vol. 19, No. 2.) In this series variations in the water-cement ratio were not studied as such, but certain of the data provide an opportunity for comparison on this basis. Thus, two

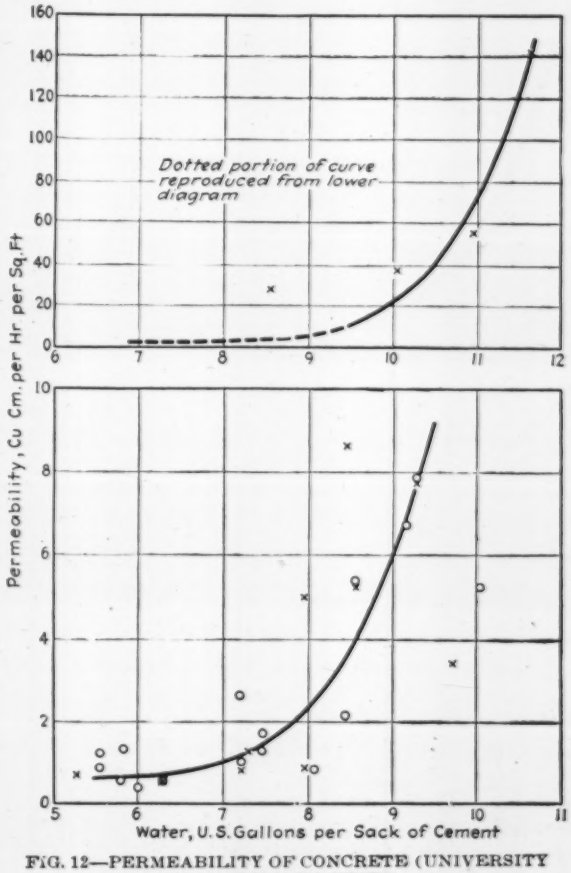

Dotted portion of curve reproduced from lower diagram
Permeability, Cu Cm. per Hr per Sq. Ft
Water, U.S. Gallons per Sack of Cement

FIG. 12—PERMEABILITY OF CONCRETE (UNIVERSITY OF WISCONSIN TESTS)
Variable mix and consistency; damp cured; age at test, 28 days.

sets of data in Withey and Wiepking's paper—those in Table VIII, in which the water-cement ratio and consistency are variable, and those in Table VI, in which the water-cement ratio and mix are variable—can be grouped in a single study with the water-cement ratio as the basis of comparison. This has been done in Fig. 12. This figure shows the relation between the water-cement ratio and the average rate of loss of water through the specimen for the first 50 hours under test at 40 lb. per sq.in. pressure. In order to enlarge the scale for the lower values, the data have been plotted in the two sections. The dotted portion of the curve in the upper diagram is a reproduction to different scale of the curve in the lower diagram.

One feature of these tests, upon which the authors commented and which is apparent when these data are compared with other data on permeability, is the very small quantities represented by the losses shown. Many of the specimens, the authors state, did not show any dampness on the surface during test, indicating that evaporation from the surface was at least as rapid as the flow through the specimen. The quantities of water reported as leakage were determined by measuring the quantity that went into the specimen. Because of the small quantities involved, the results would be influenced by other factors than simple permeability of the pastes, such as rate of evaporation, humidity, etc.

While the points in Fig. 12 are scattered somewhat, the general trend, showing increase in leakage with increased water-cement ratio, is well defined. When the difficulties of making such tests are considered, it will be appreciated that this is a very satisfactory indication of the major influence of water content on the watertightness of concrete.

Fig. 13, taken from Fig. 4 of Building Research Paper No. 3, Department of Industrial and Scientific Research,

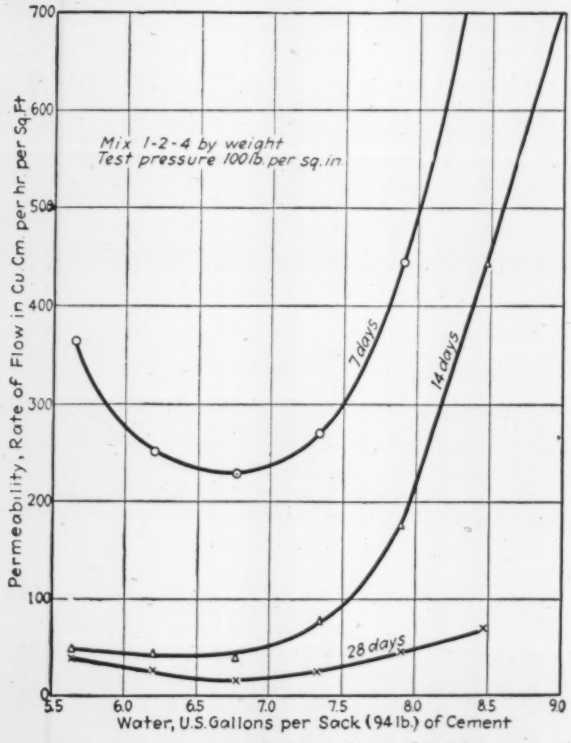


FIG. 13—PERMEABILITY OF CONCRETE (LONDON TESTS)
Constant mix; variable consistency.

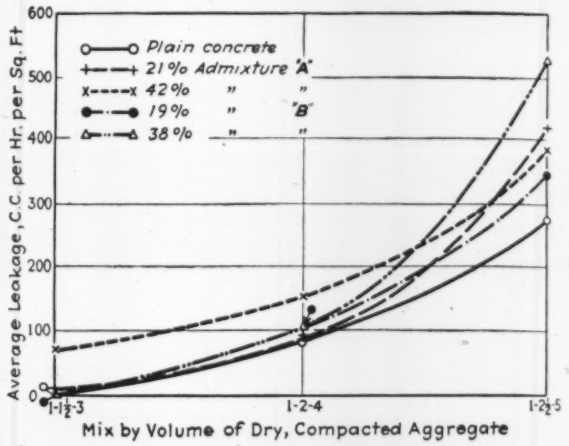


FIG. 14—EFFECT OF ADMIXTURES ON CONCRETE OF CONSTANT CONSISTENCY

London, gives some further data showing the relation between permeability and the quantity of mixing water. Here the regularity of the curves will be noted. The upward trend at the lower water ratios is deserving of comment, as it shows the importance of proper consistency. This group of tests being on a fixed mix (1:2:4 by weight), the mixtures would naturally become stiff for the lower water contents, with the result that the permeability would increase due to the difficulty of obtaining proper placement.

Fig. 14 shows a number of tests from the research laboratory of the Portland Cement Association in which plain concrete is compared with concrete containing admixtures. In these tests the mixes were all brought to the same consistency—3- to 5-in. slump. As the mixes containing admixtures require somewhat more water for the same slump, the water-cement ratios are not all the same. In Fig. 15 the same data are plotted in terms of the water-cement ratio. These curves show the same major influence of the quantity of mixing water as was shown by the preceding data. Of particular interest is the small effect of the admixtures on the leakage as compared with the large differences shown for the different water ratios.

These data, as pointed out above, are not so extensive as those bearing on the water-ratio strength relation. Nevertheless, when considered in connection with the latter, there can be no escaping the conclusion that as in the case of strength, *the water content of the paste is the major factor affecting watertightness* for a given cement and conditions of curing.

Effect of Curing Condition—In the conclusions from their studies, Withey and Wiepking point out the importance of curing as follows:

> To secure a high degree of imperviousness, concrete should be cured in a moist atmosphere or under water. At temperatures of 60 to 75 deg. F., the moist-curing period should be maintained for two weeks to a month after molding. Lean mixes or thin sections require longer wet-curing periods than rich mixes or thick sections. When it is impracticable to keep the work moist after removal of the molds, and the humidity is low, provision should be made to keep the molds in place in order to avoid evaporation. The effect of dry curing appears to be much more detrimental to watertightness than to compressive strength.

In Fig. 13 the separate curves for 7-, 14- and 28-day tests are in a measure a direct comparison of differences in curing. As pointed out in the discussion of strength

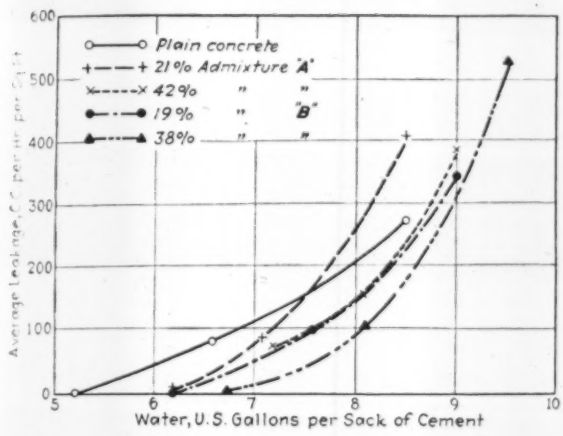


FIG. 15—EFFECT OF WATER-CEMENT RATIO AND ADDITION OF ADMIXTURES ON PERMEABILITY OF CONCRETE

Same data as in Fig. 14.

data, curing and age are not separable, the only effect of age on the strength being the opportunity it provides for further chemical union between the cement and water. This must be true also in the effect on permeability. Thus, the 14 or 7 days' moist curing in Fig. 13 is equivalent to some other conditions of curing for periods of 28 days. The curves of Fig. 13 clearly show the importance of the completeness of the chemical combinations on the resistance to the passage of water. The leakage after only 7 days of curing is four times that obtained at 14 days, and eight times that at 28 days.

The upper diagram of Fig. 16, also from the Portland Cement Association laboratory, shows the importance of duration of moist curing on the permeability of two concretes of different water-cement ratios. Here it will be observed that watertightness increases very rapidly with the additional curing developed by the increased age. The difference in leakage due to water-cement ratio can also be seen quite clearly by a comparison of these two curves.

Tests by H. Faulkner and F. D. Crook, Seattle, reported in the paper "Tests of Damp Sand Curing Improves Quality of Concrete" (*Engineering News-Record*, June 19, 1924, p. 1050) brought out most surprisingly the effect of additional curing on the resistance of concrete to the absorption of oils.

Effect of Characteristics of the Cement—Here again the experimental data are limited. On the lower diagram of Fig. 16 are plotted the only data available which show the difference in permeability between cements of different characteristics. These data are taken from tests in the laboratory of the Portland Cement Association and show the average leakage per hour for 48 hours through 1-in. disks under a pressure of 20 lb. per sq.in. The specimens were mortar mixes of constant consistency (slumps from 3 to 5 in.), the mix being adjusted to give water-cement ratios of 5, 6, 7 and 8 gal. per sack of cement. Two groups of specimens are shown —those cured moist for 3 days, followed by 7 days in the open air, and those cured moist for the entire 10 days; all specimens were tested at 10 days.

Cements *B* and *D* are standard portland cements; Cements *A* and *C* are special cements now on the market. While the data show some differences among the different cements, it is only in the case of Cement *C* that the difference is prominent enough to be of any important consideration, and this is true only for the highest water-cement ratio.

As compared with the differences between the various cements, the differences due to water ratio and to curing should be carefully noted. For example, the leakage for the cement lowest in position for the 7-gal. water ratio is about as great as that for the highest cement for the 6-gal. water ratio. Of still greater significance, however, is the matter of curing. The cement showing the highest leakage for the 8-gal. water ratio, when moist cured for an additional 7 days before test, shows a leakage of less than half that shown by the best cement for the 3 days' moist curing.

Effect of Water-Cement Ratio on Other Properties of Concrete—In Fig. 17 are shown the results of transverse and tensile tests of concrete at various ages plotted in terms of the water-cement ratio. The upper group of curves represents the tensile strength and the lower group the modulus of rupture. The same characteristics of the water-cement ratio strength relation will be noted in this group as found for the compressive strength shown previously. Other tests have shown that the characteristics of the aggregates affect the transverse strength to a greater degree than the compressive strength. The important effect of curing can also be seen from Fig. 17 by the increase in strength with age as indicated by the separate curves. These data are taken from a paper by Gonnerman and Shuman, entitled "Compression, Flexure and Tension Tests of Plain Concrete," presented before the American Society for Testing Materials, June, 1928.

In a paper entitled "Some Accelerated Freezing and

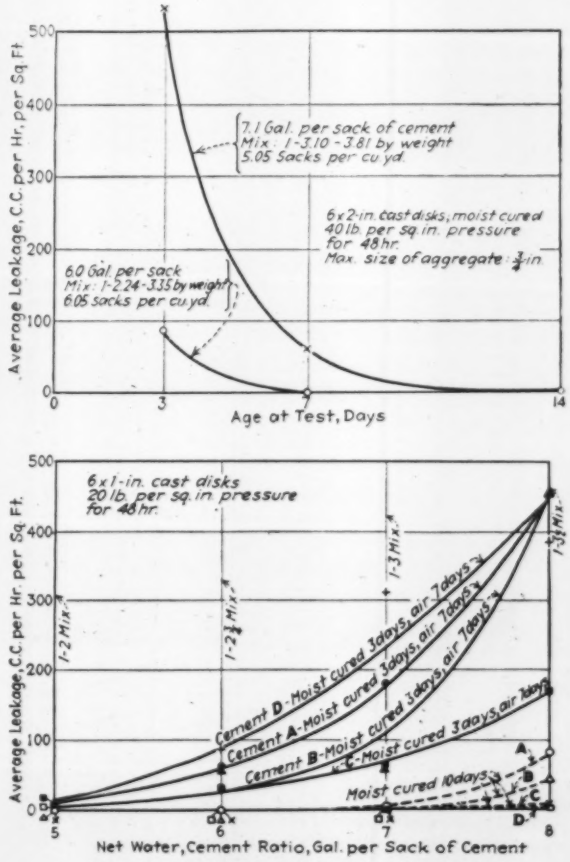

7.1 Gal. per sack of cement
Mix: 1-3.10-3.81 by weight
5.05 Sacks per cu yd.
6 x 2-in. cast disks, moist cured
40 lb. per sq. in. pressure
for 48 hr.
Max. size of aggregate 3/4 in.
6.0 Gal. per sack
Mix: 1-2.24-3.35 by weight
6.05 sacks per cu yd.
Average Leakage, C.C. per Hr. per Sq. Ft.
Age at Test, Days
6 x 1-in. cast disks
20 lb. per sq. in. pressure
for 48 hr.
1-2 Mix
1-2½ Mix
1-3 Mix
1-3½ Mix
Cement D-Moist cured 3 days, air 7 days
Cement A-Moist cured 3 days, air 7 days
Cement B-Moist cured 3 days, air 7 days
Cement C-Moist cured 3 days, air 7 days
Moist cured 10 days
Average Leakage, C.C. per Hr. per Sq. Ft.
Net Water, Cement Ratio, Gal. per Sack of Cement

FIG. 16—PERMEABILITY OF CONCRETE

Thawing Tests on Concrete," by C. H. Scholer, presented before the American Society for Testing Materials in June, 1928, there are some very interesting data showing the relation between the water-cement ratio and the resistance of concrete to destructive effects of alternate freezing and thawing. Fig. 18, which is reproduced from Fig. 7 of this paper, shows the relation between strength and water ratio and number of cycles required to disintegrate completely the specimens in the freezing and thawing test. In commenting on these data Professor Scholer points out that for the higher water ratios the specimens failed distinctly by mortar disintegration, while "for the lower water ratios the disintegration of the stone is playing a very important part. In fact, most if not all of the failure in the specimen of 0.6 water-cement ratio appears to have been due to the failure of the coarse aggregate." From this statement it is evident that if the curve on Fig. 18, representing the relation between cycles and water-cement ratio, could be made to represent only the resistance of the paste, it would resemble still more closely the curve between strength and water-cement ratio.

Summary

In the data which have been presented it has been shown that the major factors governing the properties of concrete are those which determine the properties of the hardened cement paste—namely:

1. The characteristics of the cement.
2. The proportion of water to cement.
3. The extent of the curing.

For a given cement and condition of curing, the proportion of water to cement has been established as the major factor in controlling both the strength and watertightness. Differences in cement quantity, aggregate proportions, size and type of aggregate, and grading are seen to affect the concrete only through their effect

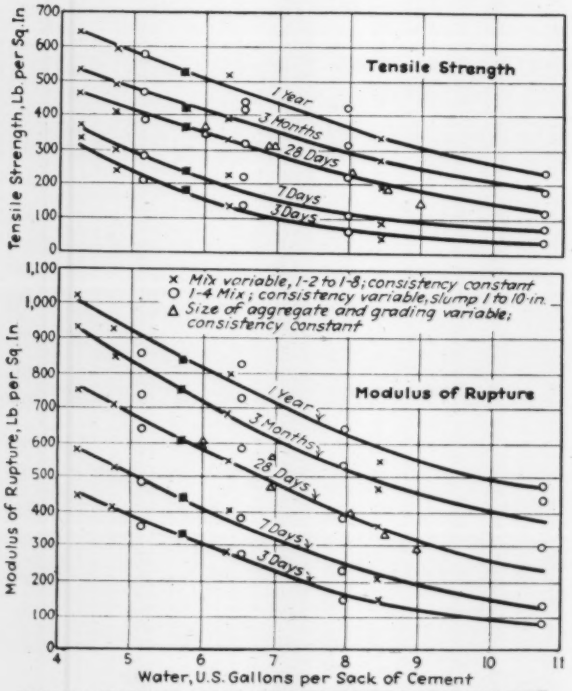

Tensile Strength
1 Year
3 Months
28 Days
7 Days
3 Days
Tensile Strength, Lb per Sq In
× Mix variable, 1-2 to 1-8; consistency constant
○ 1-4 Mix; consistency variable, slump 1 to 10 in.
△ Size of aggregate and grading variable; consistency constant
Modulus of Rupture
Modulus of Rupture, Lb per Sq In
Water, U.S. Gallons per Sack of Cement

FIG. 17—EFFECT OF WATER-CEMENT RATIO ON THE TENSILE AND TRANSVERSE STRENGTH OF CONCRETE
Moist Room Curing.

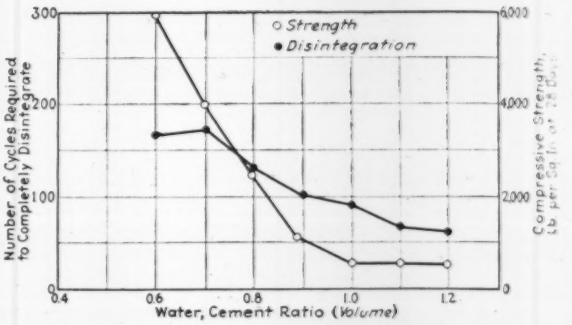

○ Strength
● Disintegration
Number of Cycles Required to Completely Disintegrate
Compressive Strength, Lb per Sq In. of 28 Days
Water, Cement Ratio (Volume)

FIG. 18—TESTS ON 3x8-IN. CORES CUT FROM 1:2:3½ CONCRETE HAVING VARIABLE WATER-CEMENT RATIO

Frozen at —15 to —25 deg. F.; thawed at 70 deg. F. From paper by C. H. Scholer in *Proceedings* of A.S.T.M. for 1928.

on the amount of water required in the paste to produce the desired plasticity.

The effect of curing and the influence which the characteristics of the cement have on the rate of chemical combination between the water and cement are seen to be of an importance comparable to that of the quantity of mixing water.

Through these data there has been established a basis for the design of mixtures to meet the requirements of a particular structure. As brought out in the first article, such design introduces two steps, as follows:

First, the selection of the proportion of water and conditions of curing which will give a paste to meet the requirements of the particular structure as to strength, watertightness or weather resistance.

Second, to find a combination of aggregate which, with this paste, will give a mixture that is plastic and which will remain homogeneous during placing and through the setting and hardening period.

In the next article consideration will be given to the aggregate proportions and other factors involved in the combination of aggregates with the cement paste.

Mr. McMillan's third article will appear April 25.

Typhoid Decline in Maryland

Typhoid mortality in the State of Maryland for the year 1928 was at the rate of 5.2 per 100,000. This was the lowest on record and shows a decline from the rate of 16.9 for 1918 and 42.8 for 1910. The typhoid death rate in the city of Baltimore for 1928 was 4.2, compared with 11.6 in 1918 and 41.9 in 1910. For the entire state, excluding Baltimore, the corresponding rates were 6.5, 21.1 and 43.5. The 1928 record, states Abel Wolman, chief engineer, Maryland Department of Health, in his report for 1928, is "gratifying in spite of the occurrence during the past summer of small epidemics of typhoid fever, the outstanding one of which was at Eastport," an unincorporated community in which 30 to 35 cases "were detected." At the time of the outbreak Eastport had neither a public water supply nor sewerage systems. The typhoid outbreak followed a heavy storm with high tides (which may have backed up the water in the 500 shallow wells supplying the community). An engineer under the direction of Mr. Wolman "spent some 30 days in educating the public up to the point of requesting public water supply and sewerage systems" and making other sanitary improvements. Before the end of the year a water-distribution system was installed.

Oxygen Torch Used on Difficult Under-Water Work

By Charles Kandel
General Manager, Craftsweld Equipment Corporation, New York City

CUTTING steel with an oxygen torch, drilling concrete and setting forms in water varying in temperature down to 32 deg. F. and in depths from 25 to 70 ft. were some of the major tasks performed by divers in replacing an old steel trash rack with one of new design at a Southern hydro-electric plant of the Aluminum Company of America. Almost every known tool for work under water was used with uniformly good results. Incidentally, the complete kit of tools exclusive of the oxygen tanks weighed less than 50 lb.

The old rack structure contained about 25 tons of steel made up of six 24-in. I-beams 25 ft. long with their ends embedded in concrete, one 12-in. I-beam 50 ft. long, five 4-in. I-beams each 50 ft. long and two 4-in. channels 50 ft. long. In addition there were about 5,000 ft. of 4x½-in. flat bars riveted together into eighteen separate racks attached to the main structure. The racks had been in service for more than ten years and had accumulated a coating of heavy rust and hardened silt of a highly refractory nature. Another factor which complicated matters was the presence of oak lagging 4 in. thick on both sides of the webs of the 24-in. I-beams. The visibility also was poor because of a high-silt content of the water.

The low temperatures encountered made it necessary to equip each diver with four suits of heavy woolens, one heavy sweater, fleece-lined woolen headgear, four pairs of homespun woolen socks, heavy felt boots and two-ply woolen gloves. Thus equipped, the divers were able to stay down for periods of 60 to 110 minutes, either until their fingers were too numb for further work or until the air lines became frosted.

Approximately 50 individual cuts were made totaling 65 lin.ft., the cuts varying from 8 to 36 in. in length and from ½ to 2 in. in thickness. The actual cutting time

FIG. 1—DIVER HOLDING TORCH AND PNEUMATIC HAMMER USED IN UNDER-WATER REMOVAL OF OLD TRASH RACK

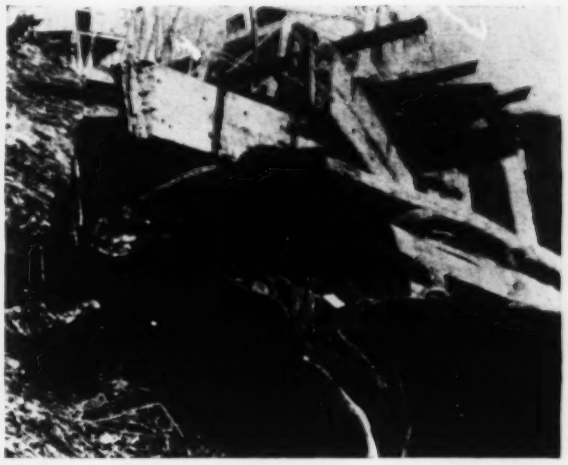


FIG. 2—SOME OF THE STEEL REMOVED UNDER WATER
Note wood lagging on both sides of I-beams which had to be cut with pneumatic hammers before oxygen torch could reach steel.

was about nine hours. When a section of the rack structure was cut loose it was raised to the surface by a derrick on the intake floor. Difficulty was experienced in preheating the steel through the coating of heavy rust and hardened silt, and this was finally overcome by the use of a scraper in the hands of the diver at the point where the cut was to be made. The 4-in. wood lagging on the webs of the 24-in. I-beams also presented difficulties and a pneumatic hammer weighing about 8 lb. equipped with a wood-cutting chisel solved the problem effectively.

The second stage of the project included reinforcing the side walls of the inlet bay to take the new trash rack. This necessitated the attachment of concrete forms and the pouring of the concrete under water. For attaching the forms a total of 60 $1\frac{3}{16}$-in. holes 5 in. deep were drilled at various levels under water with the aid of a pneumatic hammer, and expansion bolts were inserted into these holes to carry 5-ft. sections of forms. A maximum of eighteen holes was drilled in a two-hour dive. In order to lay out these forms careful measurements were made under water and a templet was assembled there. This was then raised to the surface and used for drilling the first form section.

During the pouring of the concrete a diver with the aid of a pneumatic hammer and a submarine light calked each crevice in the forms with oakum as leaks appeared. The submarine light was particularly valuable because of the high silt content of the water. The light was operated on an ordinary lighting circuit and utilized 500-watt lamps.

Another effective tool which was used on the work was a special nozzle weighing about 10 lb., which was used for dredging in corners and other spots inaccessible to the clamshell bucket. This nozzle was first used in salvaging the submarine "S-51," on which job divers were able to tunnel under the keel of the boat at a depth of 138 ft.

The equipment and and skilled personnel used on the work were supplied by the Craftsweld Equipment Corporation, New York City. The personnel consisted of two expert divers headed by John R. Kelley, who was decorated for his skill in the salvaging of the U. S. submarines "S-51" and "S-4."

Relative Values of Public Utility Systems

Comparison of Variations in Main Items Making Up Physical Values of Five Classes of Utilities

By C. F. Lambert

Burns & McDonnell Engineering Company, Kansas City, Mo., and Los Angeles, Calif.

RELATIVE costs of five classes of public utilities, as here charted and tabulated, bring up to Jan. 1, 1929, the values which have been recorded periodically in articles published in *Engineering News-Record* of May 7, 1925, p. 768; July 22, 1926, p. 163; July 28, 1927, p. 163; and April 12, 1928, p. 609. The original article was based on valuations of 25 water-works, electric light and artificial gas systems, ten street railway systems, and eleven natural gas systems. These appraisals have been made covering a period of years of properties scattered all over the United States. Since that time some systems have been added and others dropped, keeping the average number about the same. In this way any change in relative proportion of various items entering into the properties has been taken care of.

Fig. 1 shows the relative yearly value of power-plant buildings, separately for labor and material in the proportion in which each enters into the cost of a power-plant building or pump station.

Fig. 2 and Table I show the yearly value and five- and ten-year averages for water-works systems. These figures are based on 25 systems in various parts of the United States, and on 68 separate items going to make up the total.

Fig. 3 and Table II show the same information for electric light plants. These figures are based on 25 systems and on 84 separate items going to make up the total.

Fig. 4 and Table III, showing the same information for street railway systems, are based on 10 systems and 82 separate items.

Fig. 5 and Table IV, showing the same information

TABLE VI—RELATIVE VALUES BASED ON 1926 AS 100 PER CENT

	1913	1923	1924	1925	1926	1927	1928
Water-Works							
Land	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Buildings	5.9	11.0	11.0	10.9	11.0	10.7	10.9
Equipment	6.4	12.1	12.2	12.1	12.0	11.9	12.2
Distribution	38.6	79.3	80.6	75.8	74.4	67.5	65.9
Miscellaneous	0.6	1.2	1.1	1.1	1.1	1.0	1.0
Total	53.0	105.1	106.4	101.4	100.0	92.6	90.9
Electric Light Plants							
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Buildings	5.9	10.9	10.8	10.8	10.8	10.6	10.6
Equipment	22.7	42.8	42.8	42.9	42.5	41.9	42.3
Distribution	26.1	40.1	40.5	41.3	41.6	41.4	42.5
Miscellaneous	2.0	3.6	3.6	3.6	3.5	3.3	3.3
Total	58.3	99.9	99.3	100.2	100.0	98.8	100.4
Street Railways							
Land	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Buildings	2.7	5.1	5.0	5.0	5.0	4.9	4.9
Track construction	37.1	65.5	65.1	63.6	63.6	62.7	62.9
Span construction	3.3	5.0	5.1	4.7	4.6	4.7	4.8
Cars and equipment	12.1	27.1	24.8	23.5	23.5	23.5	23.0
Miscellaneous	1.0	1.9	1.8	1.8	1.8	1.8	1.7
Total	57.7	106.1	103.3	100.1	100.0	99.1	98.5
Natural Gas Plants							
Land	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Buildings	0.9	1.5	1.5	1.6	1.6	1.5	1.5
Equipment	0.9	1.7	1.7	1.6	1.6	1.6	1.6
Distribution	49.1	89.9	92.3	93.3	93.0	90.6	90.8
Miscellaneous	1.5	3.1	3.0	2.9	2.9	2.8	2.8
Total	53.3	97.1	99.4	100.3	100.0	97.4	97.6
Artificial Gas Plants							
Land	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Buildings	3.6	6.7	6.7	6.6	6.7	6.5	6.4
Equipment	16.2	33.8	32.6	32.2	32.3	32.1	31.9
Distribution	30.1	57.2	57.8	57.1	56.8	54.0	53.8
Miscellaneous	1.1	2.2	2.1	2.1	2.0	2.0	2.0
Total	53.2	102.1	101.4	100.2	100.0	96.8	96.0

RELATIVE YEARLY VALUES OF MAIN ITEMS ENTERING INTO PHYSICAL VALUES OF FIVE CLASSES OF PUBLIC UTILITIES

Table I—Water-Works Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Land	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Building	11.2	10.8	11.1	13.3	16.5	18.5	20.6	25.6	20.9	19.0	20.8	20.7	20.6	20.7	20.2	20.1
Equipment	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.0	23.4	21.8	22.9	23.0	22.9	22.7	22.5	23.0
Distribution	72.7	67.1	71.3	94.1	143.2	161.1	165.8	197.8	155.8	130.1	149.8	152.2	143.2	140.5	127.5	123.8
Miscellaneous	1.1	1.1	1.1	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.2	2.0	2.1	2.0	1.9	1.9
Total	100.0	93.9	100.4	129.0	187.0	207.9	215.9	255.1	205.2	175.8	19.86	200.8	191.7	188.8	175.0	168.8

Table II—Electric Light Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Land	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Building	10.1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	19.9	17.1	18.8	18.6	18.5	18.6	18.2	18.2
Equipment	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73.6	73.0	72.0	72.9
Distribution	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	70.9	71.2	71.1	72.9
Miscellaneous	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6.1	6.0	5.7	5.6
Total	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	190.5	171.6	171.6	170.6	171.9	171.6	169.8	172.4

Table III—Street Railway Systems

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Land	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Buildings	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8.6	8.6	8.5	8.5
Track const.	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110.2	110.2	108.6	108.5
Span const.	5.8	5.4	6.3	8.7	9.9	9.7	10.0	11.1	9.0	8.5	8.7	8.8	8.1	8.0	8.1	8.4
Cars & equip.	20.9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40.7	40.7	40.7	39.9
Miscellaneous	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3.2	3.2	3.1	3.0
Total	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.4	173.3	171.6	170.9

Table IV—Natural Gas Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Buildings	1.6	1.6	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	2.9	3.0	3.0	2.9	2.9
Equipment	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0
Distribution	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.2	175.0	174.6	169.9	170.3
Miscellaneous	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.9	5.7	5.5	5.4	5.3	5.2
Total	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.2	186.5	188.1	187.6	182.7	183.0

Table V—Artificial Gas Systems

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Land	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Buildings	6.8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12.4	12.5	12.2	12.1
Equipment	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.2	60.5	60.6	60.3	59.4
Distribution	56.5	54.4	55.6	68.0	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	107.3	106.7	101.5	101.0
Miscellaneous	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.2	4.0	3.9	3.8	3.8	3.7
Total	100.0	96.3	101.7	132.7	192.0	202.5	204.5	231.5	203.2	180.8	191.9	190.5	188.3	187.8	182.0	180.4

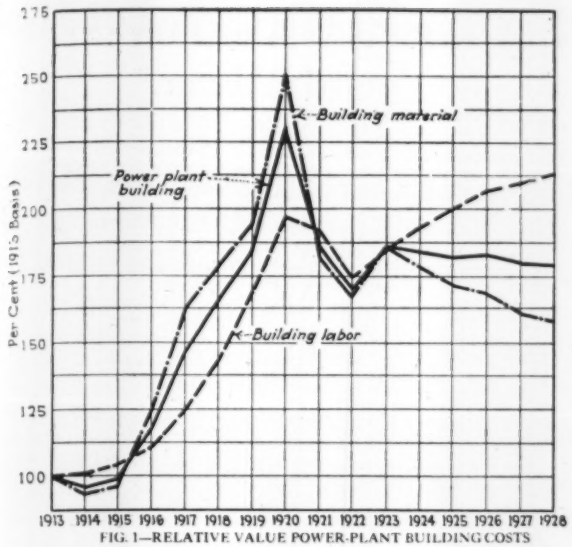


FIG. 1—RELATIVE VALUE POWER-PLANT BUILDING COSTS

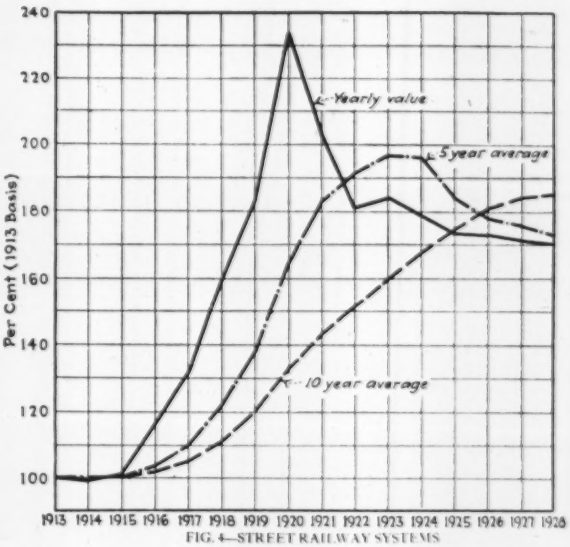


FIG. 4—STREET RAILWAY SYSTEMS

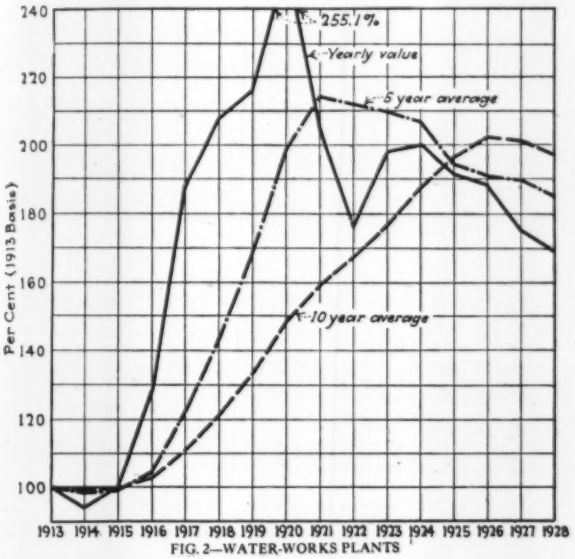


FIG. 2—WATER-WORKS PLANTS

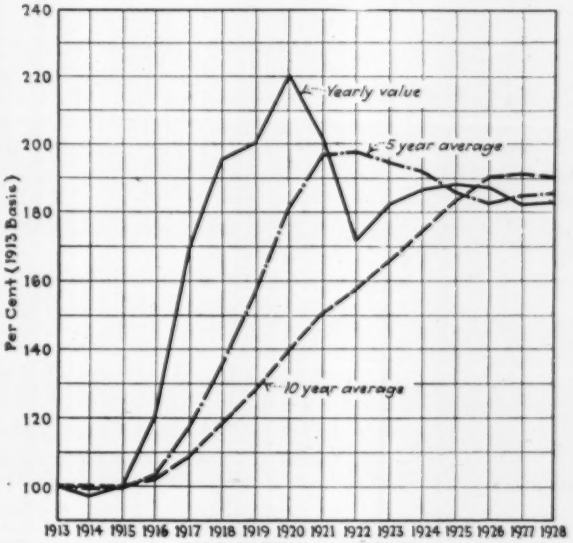


FIG. 5—NATURAL GAS SYSTEMS

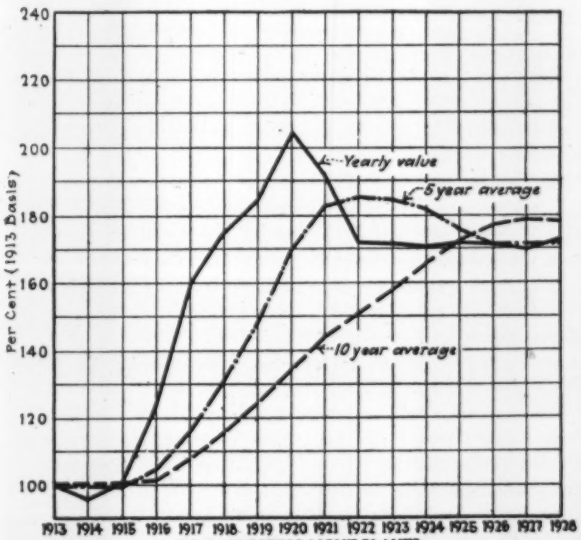


FIG. 3—ELECTRIC LIGHT PLANTS

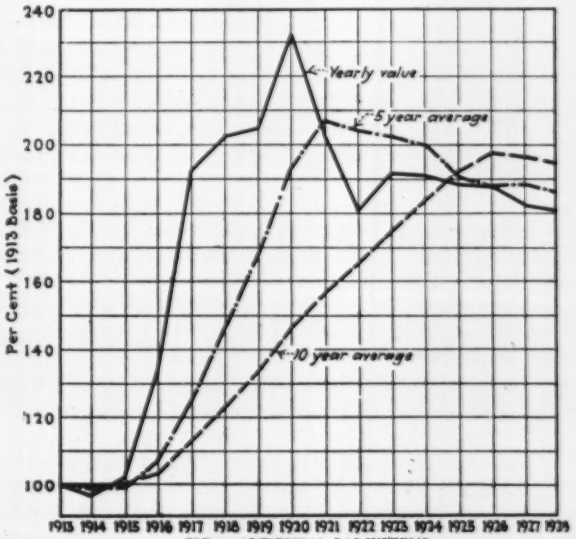


FIG. 6—ARTIFICIAL GAS SYSTEMS

RELATIVE YEARLY VALUES OF FIVE CLASSES OF PUBLIC UTILITIES AND POWER-PLANT BUILDING COSTS

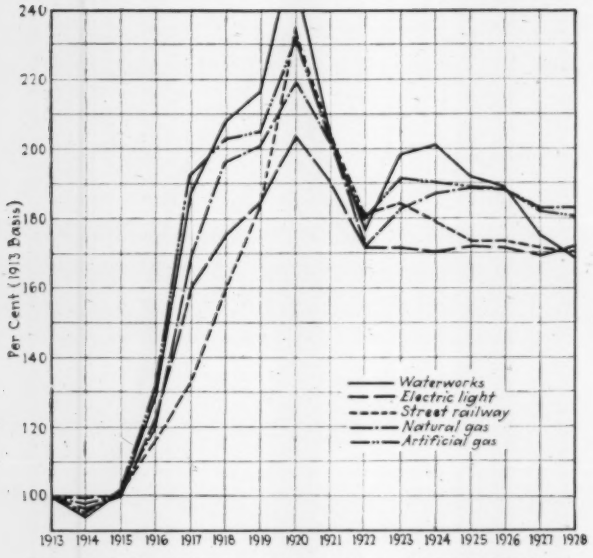


FIG. 7—RELATIVE YEARLY VALUE OF FIVE TYPES OF UTILITIES

for natural gas systems, are based on 11 systems and 58 separate items.

Fig. 6 and Table V, for artificial gas systems, are based on 25 systems and 63 separate items going to make up the total.

Fig. 7 shows on one sheet the relative value of the five different utilities.

As recent government figures show relative values based on 1926 values as 100 per cent, Table VI has been prepared, giving 1913 and 1923 to 1928 values on this basis.

Electric Railway Work in 1928

With 239 miles of electric railway track built in 1928, city lines had 184 miles and interurban lines 55 miles, according to the annual statistics of *Electric Railway Journal*. There were 586 miles of track abandoned entirely by 27 companies, but eleven of these lines are now operated by motor coaches. With partial abandonment by other companies totaling 260 miles for city lines and 330 miles for interurban lines, the aggregate length abandoned was 1,176 miles. On the other hand, more than 5,000 route-miles of bus or motor coach extensions were established by electric railways. The total mileage of track of city and interurban electric railway, including Canada, is 43,400 miles.

Underground electric rapid-transit mileage for fifteen cities in nine countries, three of these railways being in the United States, is given as 284 route-miles, with 673 miles of track. New York leads with 86 and 261 miles; Paris is next with 59 and 118 miles, and London comes third with 57 and 115 miles. Electrification of trunk-line railways in this country was increased by 267 track-miles during 1928 and now aggregates 1,845 route-miles, with 4,126 miles of track. The Chicago, Milwaukee, St. Paul & Pacific Railway heads the list with a stretch of 655 route-miles. Important new projects definitely adopted are those of the Pennsylvania Railroad, for 325 route-miles and 1,300 miles of track; the Delaware, Lackawanna & Western Railroad, 78 and 173 miles, and the Reading Railroad, 50 and 110 miles. Electrification in other countries aggregates about 15,000 miles of track.

A Farewell Word on the Venturi Meter

Some Remarks on Its Application and Possibilities

By Clemens Herschel
Civil Engineer, New York City

After all has been said, 87 years seems a good old age, although the holder of it may not have recognized this as time has gone along. But on reflection he will come to the conclusion that if he has any messages to leave to his comrades in the battle of life he had better be about it. One such message the writer has in mind at this moment. It relates to a prominent piece of work of his, one that has conquered a standing on its merits throughout the world. I allude to the Venturi meter, now more than 40 years old, a device of which between 30,000 and 40,000 are in use but which has possibilities as yet largely unutilized.

So far as the writer has been able to learn, this is the only meter for liquids or gases in existence which can with almost full truth be called a minimum-loss-of-head meter. Aside from this distinction, it has the merit of surprising simplicity, being in truth no instrument at all but merely a specially shaped piece of pipe inserted in the regular pipe or penstock conveying a gaseous or liquid substance. Hence its cost is only the difference in cost of a length of special as compared with an equal length of standard pipe.

Of, course, there may be added to this engineer's water-measuring apparatus—and to justify the term "meter" as ordinarily used *must* be added—a registering and recording apparatus, thus saving the employment of an observer, his pencil and notebook; but the original invention did nothing of this sort, the invention and development of the meter-producing additions to the apparatus having been the work mainly of F. N. Connet, of Providence.

James B. Francis' Contribution

It is most interesting in this day of hydraulics to recall that for its inherent low-loss characteristic the Venturi meter owes a debt to that old master, James B. Francis. The summit angle of the cone of the downstream tube was selected from Francis' experiments on the flow of water through diverging tubes as the one causing a minimum loss of head. It is the same angle which has been found most efficient for turbine draft tubes.

Looking back, it is surprising to observe the slowness of hydraulic engineers to perceive the merit of simplicity and yet virtual perfection of the device—for it would appear that its small losses of head and its unapproached precision of measurement may properly merit this extreme term. Yet there have been many who chose clumsier and costlier devices for hydraulic measurement. Weirs, for example.

One would think, reading some of the letters the writer has received in the course of time, that weirs and the like cost nothing; or at least that *their* cost must be met and cannot be avoided. Is a weir less costly? It is difficult to find data on this point, weir costs being so generally considered mere carpenter work and unavoidable. But an instructive example may be found in *Power Plant Engineering* of Aug. 1, 1927. Some ultra-conservative having prescribed the weir as the proper

instrument, among others, to determine the efficiency of the turbines, construction of weirs cost more than $70,000, as against some $7,200 for applying the Gibson method; and, while I can make no estimate at this distance of place and time of what the cost of Venturi meters would have been, I am very certain it would have been less than half of the $70,000 that was spent for weirs.

Incidentally, be it remarked that in power plants, either in the penstock or in the tailrace, the Venturi *principle* may be applied to meter discharges. This has recently been most successfully done at Conowingo, metering continuously by one instrument quantities up to 7,500 sec.-ft.

Some Forms of Flow Meters

For some curious reasons which the writer has never been able to understand, various attempts have been made to substitute some other form for the Venturi meter. We have, among other substitutes, a "Venturi flume," an empirical structure, metering water empirically between limits, which certainly does not cost less than a plain Venturi meter tube built of wood and acting according to well-defined and tried laws of hydraulics. We have also a distorted form of the true Venturi meter, in which the meter tube is shortened by increasing the cone angle of the discharge tube, thereby destroying the very principle embodied in the instrument—namely, that of regaining the head in full measure. And apparently the motive was to save the cost of the extra length, overlooking the fact that the gap must be bridged by the builders of the rest of the conduit at their cost and expense. Yet, as the original patents expired long ago (1903), the Venturi meter is free to any one to build, so that there can be no reason whatever for the departure from true form.

Power and Pressure Differential

But causing the least loss of head is not the sole advantage of the long taper of the discharge tube. Another is that this long cone delivers the water in a more kinetic form, if that be the proper adjective to use; or with less turbulence; so that in the case of Pelton wheels, for example, the long diverging tube will produce the maximum horsepower. And it produces a more perfect "differential."

And yet this delusion for saving money by shortening the Venturi meter tube is still being advocated, until today one hears of arguments and offers to have no downstream cone at all, only an orifice to produce a differential of pressure and to meter the water; something which the writer deliberately rejected as a poor thing more than 40 years ago, at the time he was testing and developing the Venturi meter as it started out on its triumphant career to supply a method for metering liquids and gases without upper or lower limit as to the quantity to be metered. Query: When metering water and other liquids does any one want the loss of head an orifice necessarily entails in the vast majority of cases; the gross obstruction this places in the conduit, to catch substances both heavy and light accidentally brought down to the baffle plates; the gross irregularities this produces in the body of water downstream from the meter?

There are a few cases when metering water and other liquids, and more generally when metering steam and other gases, in which orifices properly find an application; but these take us out of and away from the consideration of the Venturi meter. They are still flow meters, but not Venturi meters. As has been concisely and aptly said: "If we use a device that does not regain head, then we have to be satisfied with a small differential; and with differentials less than one-tenth inch of mercury we get into the region of uncertain and unstable coefficients, which is another reason why orifices are not good for water-works."

And all this time it must be remembered, coming back to the Venturi meter, that any length of conduit not replaced by a length of meter tube must be bridged over by an equal length of standard or normal conduit.

One wide-awake chief engineer finally stipulated in his specifications that a given length of conduit must be constituted by the meter tube; or else by the meter plus such a length of normal conduit as would be sufficient to fill in the deficiency. This still does not, however, touch the question of quality of service. Of course, a better form of specifications that might be adopted would be to specify the cone angle.

Suggested Adaptations

But there is another point connected with the cost of metering by Venturi meter that has hardly been touched upon in the meter's life of over 40 years; and that is a meter tube, or meter construction, at the lowest attainable figure. The normal meter tube has been a special steel or cast-iron casting, fitted with a full complement of registers and recorders. And properly so in the instances served. But there is now opportunity to extend the market to other cases. There is nothing to hinder, for example, building Venturi tube forms of wood, inside of standard or normal cast-iron or riveted steel pipes or penstocks.

One of the first two Venturi meters ever built, in 1886, was thus built of wood inside a 9-ft. penstock, all the material (except the throat piece) having been entered and again removed through a handhole cut for the purpose. Three Venturi meters which were built of wood inside standard 48-in. cast-iron pipe on the Newark water supply in 1891 have been doing their duty night and day ever since, and will probably last as long as the pipe lasts. On the Acquedotto Pugliese in Italy, mainly an irrigation enterprise, there are some 400 Venturi meters, fashioned of masonry or concrete.

The day is now here when Venturi meters built of wood inside the existing penstocks could measure the daily consumption of water by turbines on established water-power plants; and at a less cost, with or without registers and recorders, than by any other method as followed during my 25 years' experience on New England water-power plants.

Many are the cases in which the whole Venturi meter, all but the throat piece, could be built of wood or concrete. Indeed, the three 17-ft. concrete meters on the Ashokan works supplying New York City are examples of that sort of meter construction. Let any one carefully examine these huge meters, and then say whether, barring their registers and recorders, they have cost materially more than an equal necessary length of 17-ft. conduit.

If these lines shall have caused a brother hydraulic engineer to consider carefully which is the better, a Venturi meter designed to act as nearly perfect hydraulically as can be foreseen or else a debased form of it, or even an orifice, to meter water on works of water supply, irrigation and water power, their object will have been attained.

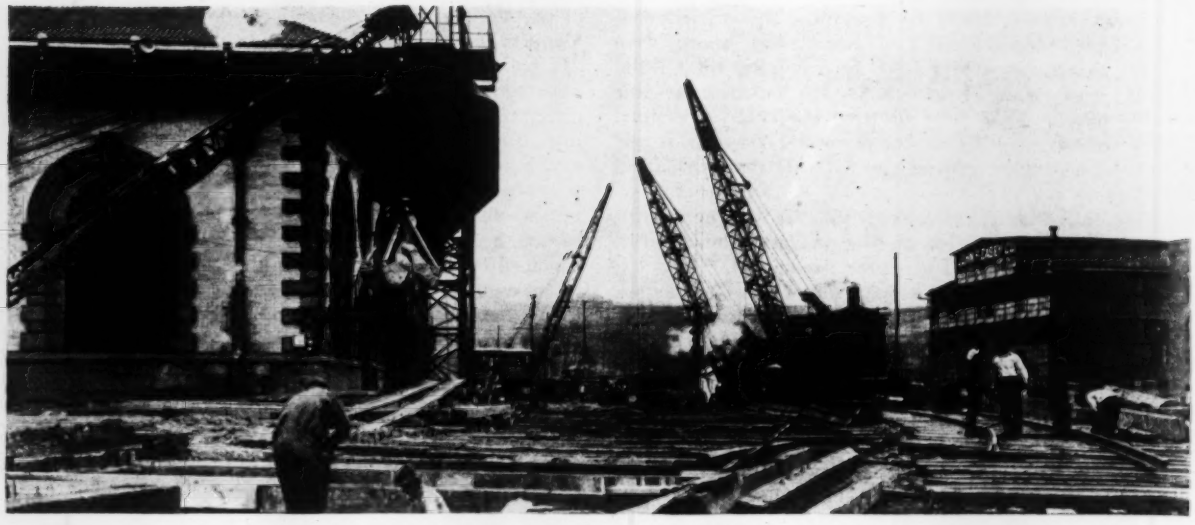


Fig. 1—View North, Showing Proximity of Trench to Buildings

Deep Trench Emergency Intake for Pittsburgh Water-Works

Twin Conduits of Concrete Constructed in Trench 32 Ft. Wide and 54 Ft. Deep and Requiring Pumping of 5,000,000 Gal. Daily

By Ross M. Riegel

Designing Engineer, Department of Public Works, Pittsburgh, Pa.

IN MAKING pump replacements in 1928 at Ross pumping station, the primary station of the Pittsburgh, Pa., water-works, dangerous conditions in the concrete-lined conduit to the pumps from the river were discovered. The leakage was so great that it was barely possible to install a temporary bulkhead required by the replacement operations in the suction trunk under the station and it was feared that if the conduit were laid dry complete collapse might take place. This would virtually shut off the city water supply. It was decided therefore to construct a new intake and in view of the situation it was made an emergency operation.

Old Conduit Structure—As shown by Fig. 2, the suction trunk under the station was connected with the river by an intake 8 to 10 ft. in diameter and 250 ft. long, with an inlet structure containing various controlling gates. The floor of the intake was 22 ft. below pool level and 44 ft. below the ground surface. This great depth was adopted, as is usual practice along the river, to insure ample water in case a dam failure should drop the pool level some 10 ft.

When the progress of the new work permitted full examination, it was found that the leakage in the old intake had been chiefly in the floor and that gravel from below the conduit was being washed into it. It was also found that extensive cracking had occurred and that the walls were porous in a number of places. It was evident that the concrete was gradually disintegrating.

After the new work had reached the stage where the safety of the water supply was assured, the old conduit was pumped out at a suitable opportunity and the smaller leaks were calked with lead wool. The worst leak was plugged by grouting under water by a diver. The conduit structure exhibits, however, certain signs of structural weakness and also a deterioration of the concrete which render it probable that even with the repairs its life is limited.

Emergency Plan—The Department of Public Works recommended to the City Council and the Mayor on April 10, 1928, that an alternative intake be constructed, and emergency legislation was at once enacted authorizing the work of addition.

The general plan adopted (Fig. 2) was to excavate a sheeted trench from the easterly end of the pumping station to the river. As soon as this trench could be completed water could be admitted to the station by breaking in the blind end of the suction trunk, if the existing conduit should collapse under further operations. The second step in the plan was to construct a new conduit in this trench, which, with an inlet control at the river, would provide a complete new suction supply to the station. The duplicate suctions would fully insure the continuity of the water supply for many years to come.

Under the emergency legislation the John F. Casey Company, of Pittsburgh, Pa., was designated as contractor. In addition to the wide experience and large resources of this company, its shops and plant adjoin the station property, and this was a decided asset in hastening the work.

General Excavation Procedure—The first step in construction was to excavate a trench 32 ft. wide, lined with 35-ft. steel sheet piling and crossbraced in the usual manner. The excavation was first carried about 24 ft. deep, at which level river water could have been admitted to the station at ordinary stages. The construction of a

stop-log control chamber adjoining the station was begun as soon as the excavation permitted, so that when the connection should be made to the station suction main a means of control would be at hand by which water could be admitted to the station at any later time in the work. By use of the same chamber, water in the old suction trunk could be excluded from the new intake construction.

For the excavation of the stop-log chamber and connection, as well as for the main conduit to the river, a second lift of trench was carried down with a second set of 35-ft. steel sheet piling, which overlapped the first by 12 ft.

Fig. 1 shows the general location of the work and its proximity to the station building, a rather monumental structure. The trench excavation was a few feet to the right of the ash-handling structure shown outside the building. Some settlement occurred in this structure, but not enough to require realignment.

Excavation Under Station—One of the principal construction difficulties was the connection of the new conduit from the stop-log chamber to the existing suction conduit under the station. The bottom of this excavation was about 23 ft. below groundwater level, and the bottom of the suction trunk was about 14 ft. below the main station foundations. This required that great care be taken to avoid settlement of the station foundations.

The procedure adopted was to extend the sheet piling of the trench across the end of the station building and suction trunk. Cement grout was then pumped into place behind the sheeting and under the suction conduit, completely filling the space between the sheeting and the conduit structure. Inasmuch as considerable flow of groundwater had taken place in the meantime, the clay and sand had been well washed out of the material in the ground adjoining the junction, leaving mostly gravel. This open gravel was quite receptive to the grout, and about 800 sacks were pumped in through fifteen pipes, the water in the trench being allowed to rise to groundwater level during the operation.

This operation effectually sealed the openings and stopped the dangerous flow of groundwater under the existing structure. The tops of the sheet piles were then cut off at a level that permitted the new conduit to be

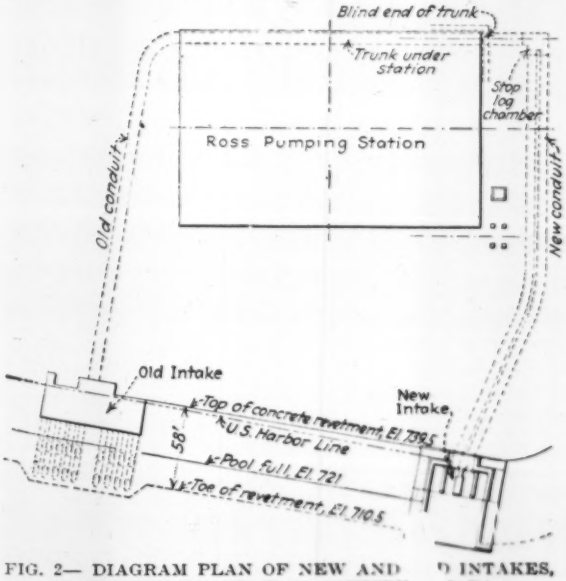


FIG. 2— DIAGRAM PLAN OF NEW AND D INTAKES, ROSS PUMPING STATION, PITTSBU I, PA.

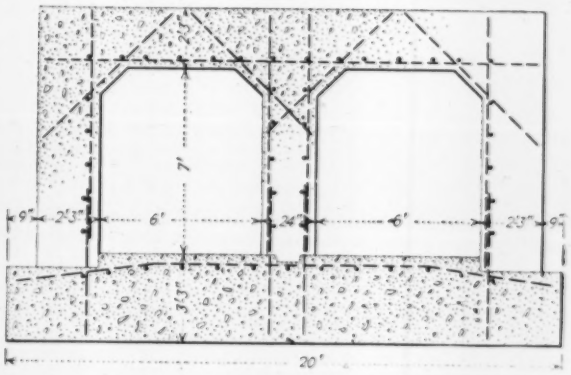


FIG. 3—TYPICAL SECTION OF NEW INTAKE CONDUIT

carried over them, the obstructing grouted material was removed as far as necessary, and a hole was cut in the blind end of the existing concrete conduit. (Water was prevented from coming back into the new conduit by the bulkhead that has been inserted in the suction conduit for the installation of a new pumping unit.) The connection was then made successfully and a tight joint secured between the new conduit and the old trunk.

Intake Conduit Structure—After some study a double reinforced box structure was decided upon. This was developed (Fig. 3) as a twin tunnel, either unit of which could be isolated for inspection and repairs by stop logs at both ends. The adopted section is rather heavy, as shown by Fig. 3, but simplicity in design was felt to be a prime consideration. Moreover, since by far the greater part of the cost of the job was incurred in sheeting and excavating the trench, liberality in the concrete sections did not constitute extravagance. This conduit was provided with copper seal strips at the construction joints and has proved to be very tight.

The permanent structure was required to be built to an invert grade of 6.0, which was 18 ft. below the crest of the navigation dam in the river and about 20 ft. below ordinary low water. This was the actual grade of the existing suction trunk in the station, and it was also necessary to construct the new inlet so that water could be admitted to the station in case of the failure of the navigaion dam before mentioned. It is the practice of public utility plants on the river to provide in their inlet works against a similar contingency.

The concrete proportions were approximately 1 : 2¼ : 3. Some extra cement was also used in the footing courses and 2 per cent of calcium chloride was in general added to the footing concrete. This was done to accelerate the strength so that bracing loads could be applied to the footing soon after pouring and other braces removed. The addition also served to counteract the effect of cold groundwater. Concrete was placed usually by drop-bottom buckets or by a modified tremie in places which the crane could not reach.

Equipment and Sheeting—The plant employed included two 30-ton steam locomotive cranes carried on railroad track and two caterpillar-mounted gasoline-driven cranes. For the construction of the river cofferdam and other work in the river, a derrick boat carrying a steam-operated revolving crane was used. A steam shovel was used when required and the earth was mainly handled by 5-yd. dump wagons drawn by tractors. The concrete-mixing plant included volume batchers and a sand inundator. Steam hammers and drop hammers were used for driving the sheet piles and a pile puller

was used quite effectively in pulling the piles. A large number of the piles, however, had to be left in the ground to protect adjacent structures against settlement. Also in some parts of the work it was found that the cost of pulling and reconditioning piles tended to exceed the salvage value and it was more economical to leave them in the ground. About 1,200 tons of steel sheet piling was used on the job, these being provided by the contractor on a rental basis.

Seepage an Pumping—The excavation in general penetrated sand and gravel and a good grade of gravel was found throughout at the foundation level. It was therefore not necessary to provide piling under the structure. The inflow of water was, however, heavy and required continuous pumping. This was mostly done by two vertical-shaft, 12-in. centrifugal pumps driven by 75-hp. motors. These were supplemented by an 8-in. and a 6-in.

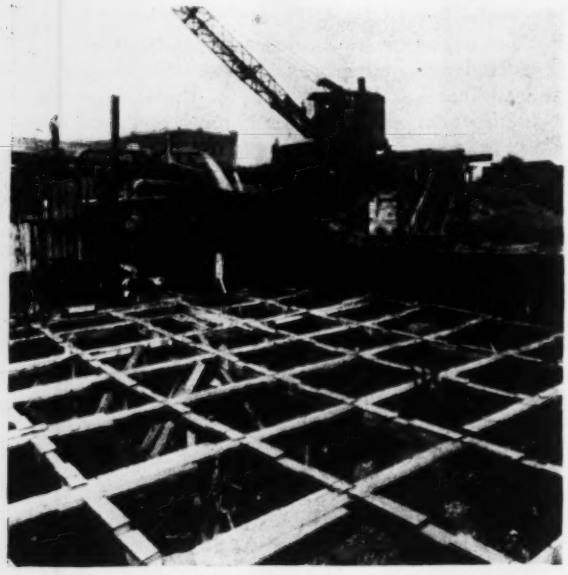


FIG. 4—VIEW OF BRACING FOR INTAKE COFFERDAM

pump of similar type and by smaller pumps. The pumps worked continuously, the only interruptions being due to lightning trouble on the power lines or to shutdown to permit grouting operations.

The pumpage was approximately 4 to 5 m.g.d. most of the time and the power demand sometimes reached 250 hp. As the river was approached the groundwater flow appeared to be heavier and there was a greater tendency for it to boil up in the floor of the conduit. Consequently the floor in this region was laid on tarpaulin, which served to prevent any washing out. Tile drains were laid under the floor to facilitate the collection of groundwater, and these crossed the trench at about 15-ft. intervals. These gradually filled up with sand but served their purpose before becoming clogged. In two cases sheet-piling bulkheads were driven across the trench below the conduit and locked into it to check groundwater flow. These also proved useful.

River Cofferdam—The river cofferdam to permit the construction of the inlet work was driven with 45-ft. arch web sheet piling. This cofferdam, of the box type, 20 ft. wide, was partly filled with gravel and sand from the riverbed and was braced by transverse rods and braces. However, it was found that the penetration of 20 ft. in the riverbed was not sufficient to secure stability and it became necessary to install a deck of wooden bracing inside the cofferdam in order to make it secure. This was removed as the concrete structure came up. The floor was placed in small units as the excavation permitted it, these being securely doweled together.

Fig. 4 shows the interior of the cofferdam for the inlet structure, looking toward the conduit. The double wall is evident and the single line of sheeting on the shore side is shown joining the sheeting of the main trench. The two 12-in. and one 8-in. pumps are discharging and a 30-ton crane is handling concrete with a drop-bottom bucket, the concrete having been delivered in cars on a track which traversed the trench at a level 10 ft. below the surface. The set of horizontal bracing is of interest. As just stated, it was necessary to provide additional stability for the box cofferdam. However, after the material inside the coffer had been drained for some days by pumping, it acquired much stability and stood on relatively steep slopes when the full excavation was completed. The bottom of this excavation was about 24 ft. below ordinary river level and the piling had a seal of about 17 ft. The sheet piling in the river was driven and pulled with comparative ease, fine material being penetrated for the most part.

Costs—Somewhat over $375,000 has been expended on the work, which is now completed. Without going into cost analysis, the bulk of this expenditure has been incurred in excavation and sheeting and bracing of the trench and cofferdam. About 15,000 cu.yd. of material was removed and hauled to a storage dump about ¼ mile away and hauled back again. About 3,800 cu.yd. of concrete was placed and about $25,000 was expended for the various accessories and fixtures required, such as gates, stop logs, racks, etc.

Personnel—This work was directed by the Department of Public Works of Pittsburgh, Edward G. Long, director, and Charles M. Reppert, chief engineer. The construction work in the field was in charge of E. E. Lampher, managing engineer, Bureau of Water, and Charles F. Brown, engineer in charge. The design was in charge of the writer as designing engineer of the Department of Public Works. The superintendent for the John F. Casey Company was J. M. Dorsey. The proximity of the Casey company's plant allowed other members of its staff to offer their services and advice from time to time. The skill and experience of these men were constantly available in planning the work and there was an unusual degree of co-operation between the engineers and the contractor's organization.

Province of Ontario Has 251 Water-Works

At the close of 1928 there were in the Province of Ontario a total of 251 water-works systems, according to a statement by Dr. A. E. Berry, director, Sanitary Engineering Division of the Ontario Department of Health, in *The Canadian Engineer*. Of the 251 water-works, 70 drew their supply from rivers, 53 from lakes, making 123 surface supplies; 47 depended upon deep wells and 38 upon springs, or a total of 85 underground supplies. Of 48 filtration plants, 42 were of the mechanical type, with 26 using pressure and sixteen gravity filters, while only six were of the slow sand type. Mr. Berry states that in Ontario: "Chlorination is now almost universal practice with mechanical filters and certain supplies. The total number of supplies so treated is 114, comprising over 75 per cent of the total water supplied for domestic purposes."

Supreme Court Acts in Subway Fare Case of New York

Injunction to Stop City From Enforcing Five-Cent Fare Granted in Error—State Court Declared to Have Jurisdiction

THE United States Supreme Court, on April 8, refused to pass upon the subway fare case of New York City, on the ground that the federal court injunction by which the case had been brought before it should not have been granted; the court holding that the case should have been heard in the state court.

Subways in New York City are operated by two companies, the Interborough Rapid Transit Company and the Brooklyn-Manhattan Transit Company. The Interborough operates the original system and its extensions, and also the Manhattan Elevated Railway line under lease. The company has claimed for some time that the five-cent fare to which it is limited by the franchise contract under which it operates is confiscatory. Recently it announced that it was preparing to put a seven-cent fare into effect under the provisions of the "just and reasonable" rate clause of the state public service commission law. The State Transit Commission and the city of New York immediately began action to force the company to live up to its contract. This action was stopped by an injunction which the company obtained in the Federal District Court. It was this injunction which the Supreme Court set aside.

Adequacy of 5c. Fare Not Passed On

As the case was not properly before the Supreme Court, that court did not pass upon the adequacy of the five-cent fare for the two systems of the Interborough Rapid Transit Company, nor upon other points at issue. It did, however, review the case at some length and in so doing made observations of particular significance to that case as well as to public utility regulation in general. Some extracts from the decision, which is officially termed "Supreme Court of the United States No. 159; October Term, 1928, John F. Gilchrist, Leon G. Godley and Charles C. Lockwood, constituting the Transit Commission, etc., et al., Appellants, vs. Interborough Rapid Transit Company and Manhattan Railway Company," are given below:

In support of the action below appellees maintain: The five-cent fare, originally stipulated and long observed, had become non-compensatory. Although specified in the agreements with the city under which the transit lines are being operated, that fare was not immutable, since, by implication, provisions of the public service law of 1907 directing that reasonable rates should be granted to subways, elevated and other street railways were incorporated into the contracts. The Transit Commission denied an application for compensatory rates, insisted upon observance of the five-cent one and intended to take immediate steps to secure enforcement of it. This amounted to action by the state which would deprive the Interborough company of property without due process of law, contrary to the Fourteenth Amendment.

* * *

Court Reviews Facts

After stating this claim of the company, the court proceeded to review the facts in the case, saying in part:

The Interborough Rapid Transit Company, a New York corporation, with $35,000,000 capital stock, operates elevated and subway lines in four boroughs of Greater New York City. Some of these it owns; some the city owns and lets to it for operation; others—the original elevated lines—it hired in 1903 from the Manhattan Railway Company for 999 years, agreeing to pay therefor interest on $45,000,000 of outstanding bonds, 7 per cent (now 5 per cent) on $60,000,000 capital stock of the lessor, and $35,000 annually for administrative expenses.

At this time the total yearly payment for use of elevated lines is about $4,900,000.

* * *

On the subject of the income of the transit company the court quotes the following from the city's affidavit:

"The amount of total capital stock outstanding is $35,000,000 . . . the subway earnings alone, therefore, under contract No. 3 provide for dividend payments of more than 18 per cent on the par value of the stock. . . .

"For 1927 the surplus amounted to $6,380,017.34 (the decline was due to a strike).

"For the current fiscal year ended June 30, 1928, the figures for the first six months are available and show a net surplus amounting to $3,687,000, which exceeds the surplus for the corresponding six months of the fiscal year before by $1,609,000.

"These earnings are, of course, enormous and leave no room for claim that the five-cent fare fixed by contract No. 3 is inadequate to give a fair return upon the investment of the company in the subway properties, or that the five-cent fare is without due regards of the rights of the company under the contract. . . .

"The financial difficulties of the Interborough during the past eight years have been due to the elevated lease from the Manhattan Railroad Company, and not to the subway contract with the city.

"The total fixed charges resting on the elevated division, including the dividend rentals, amounted for the year ended June 30, 1926, to $8,062,274.85. The income above operating expenses and taxes available for these charges, was only $3,936,396.50. The net revenues from elevated fell short of earning all charges, including the dividends to the Manhattan Railway stockholders, by $4,125,878.35. For the year ended June 30, 1927, the corresponding shortage amounted to $4,909,129.66."

* * *

Lower Court Exceeded Powers

In summing up the case the court said:

Considering the entire record, we think the challenged order was improvident and beyond the proper discretion of the court.

The record is voluminous; the contracts between the parties are complex, the relevant statutes intricate. No decision of this court nor of New York court authoritatively determines the question at issue. The basic one calls for construction of complicated state legislation.

To support the action of the court below it would be necessary to show with fair certainty, first, that before the original bill was filed the commission had taken, or was about to take, some improper action in respect to the Interborough company's new schedules or its application for leave to discontinue the five-cent rate and establish one of seven cents; and, second, that the five-cent rate was so low as to be confiscatory, while the proposed charge of seven cents was reasonable. We think neither of these things adequately appears from the record.

At most, prior to the original bill, the commission's members had accepted the view that it lacked jurisdiction to permit a new rate because the existing one was irrevocably fixed by lawful contracts, and had determined promptly to seek enforcement of the city's supposed rights by proceedings in the state courts. This was neither arbitrary nor unreasonable.

* * *

The power of the city to enter into contracts Nos. 1 and 2 was affirmed in Sun Publishing Association vs. the Mayor, supra; likewise the validity of contract No. 3 was declared in Admiral Realty Company vs. City of New York, supra. These cases point out that the object of those contracts was to secure the operation of railways, properly declared by statute to be part of the public streets and highways and the absolute property of the city.

Matter for State Courts

The statute under which the Interborough undertook to proceed gave 30 days after filing of the new schedules during which the commission might take action. The effect of the contracts, long the subject of serious disputation, depended upon the proper construction of state statutes—a matter primarily for determination by the local courts. The members of the commission intended to take official action appropriate to the circumstances and neither what they did nor what they intended to do gave any adequate cause for complaint.

Both the bill of complaint and the argument of counsel have proceeded on the theory that under the law of New York, clearly established by definite rulings of her courts, the contracts for operating the transit lines impose no inflexible rate of fare.

With this postulate we cannot agree. People, ex rel. City of New York vs. Nixon (229 N. Y. 356), decided July 7, 1920, is especially relied upon; but the circumstances there were radically different from those now presented.

The effect of a contract with the city, expressly authorized by amendment to the rapid transit act adopted subsequent to the enactment of the public service commission law, was not involved. The court carefully limited its opinion. And it said:

"The conditions of other franchises may supply elements of distinction which cannot be foreseen. Contracts made after the passage of the statute (Consol. laws, Chapter 48) (public service commission law) may conceivably be so related to earlier contracts, either by words of reference or otherwise, as to be subject to the same restrictions.

"We express no opinion upon these and like questions. They are mentioned only to exclude them from the scope of our decision. In deciding this case we put our ruling upon the single ground that the franchise contract of October, 1912, was subject to the statute, and by statute now can be changed."

Although both the elevated and subway lines are operated by the same company, the two systems have been treated as separate and upon this record must be so regarded. The receipts from the subways show steady increase. If this continues, the Interborough company ultimately will receive its entire investment on account of subways, with large profits.

The elevated roads, the present value of which for rate-making purposes is said to be above $150,000,000, are not prospering; their net receipts are diminishing. Appellees seek a seven-cent fare for all lines, based upon alleged present values and the requirements of a supposed unified system.

8 Per Cent Return Discussed

The claim for an 8 per cent return upon the value of subways, which are the property of the city and distinctly declared by statute to be public streets, Sun Publishing Assn. vs. the Mayor, supra, is unprecedented and ought not to be accepted without more cogent support than the present record discloses. The operating equipment supplied under contracts Nos. 1 and 2, which originally cost not more than $60,000,000; real estate valued at $300,000 and office sundries of small value is the only property connected with the subways to which the Interborough holds title, but it seeks remuneration based upon total values of all these ways and their equipment, said to represent investments amounting to $360,000,000 and present value exceeding $600,000,000.

At the current rate of return, after paying operating expenses, taxes and rentals to the city, the Interborough will realize annually from the subways more than $17,000,000.

The annual income of the elevated lines, after deducting operating expenses, maintenance, taxes, etc., probably will not hereafter exceed $4,000,000, and, as the Interborough must pay rentals therefor amounting to $4,900,000, also interest on bonds, notes, etc. (issued for third tracks, extensions, etc.), in excess of $3,000,000, its loss by reason of this lease is heavy and apparently will increase.

During 1927 passengers carried on the subway lines numbered 814,600,000; on the elevated, 359,000,000; total, 1,173,600,000. An increase of two cents upon each fare would have added to the subway receipts $16,292,000; to the elevated, $7,180,000.

The Transit Commission has long held the view that it lacks power to change the five-cent rate established by contract; and it intended to test this point of law by an immediate, orderly appeal to the courts of the state. This purpose should not be thwarted by an injunction.

Not a Unified System

Upon the record before us we cannot accept the theory that the subways and elevated roads constitute a unified system for rate-making purposes. Considering the probable fair value of the subways and the current receipts therefrom, no adequate basis is shown for claiming that the five-cent rate is now confiscatory in respect of them. The action below was based upon supposed values and requirements of all lines operated by the Interborough company treated as a unit; and the effort to support it here proceeds upon a like assumption.

The interlocutory order must be reversed. The case will be remanded to the District Court for further proceedings in conformity with this opinion.

San Francisco Reduces Vehicular Traffic Fatalities

Through various traffic controls and safety campaigns San Francisco reduced its fatal accidents from 158 in 1927 to 132 in 1928, or 16½ per cent. Comparing Decembers of the two years, the reduction was 38½ per cent, from 26 in 1927 to 16 last year.

Rapid Transit at Detroit—Its Present Status

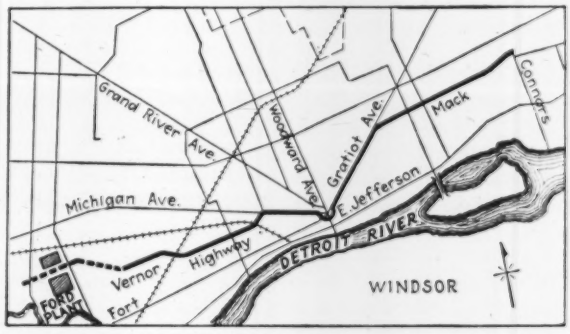
Voters Disapprove Proposal to Build First Unit of Rapid Transit System—Plan to Be Resubmitted in Another Form

FAILURE of the voters of Detroit, Mich., to approve of a subway construction plan submitted to them on April 1 was reported briefly in our issue of April 4. Rapid transit plans have been under consideration at Detroit for several years and the plan which was submitted to the voters this year called for the construction of the first unit in a comprehensive scheme for providing the whole Detroit region with better transit facilities. In view of the fact that the proposal was one of the most important rapid transit projects considered in this country, J. P. Hallihan, chief engineer of the Rapid Transit Commission, was asked to give us a summary of the plan and the prospect for its further consideration. His statement follows.

—EDITOR.

THE subway plan offered to the voters of Detroit by its Rapid Transit Commission on April 1 was defeated at the polls by a 72 per cent vote.

Physically the plan offered was the joint proposition of the Street Railway Commission and the Rapid Transit Commission, but under the state law and city charter the responsibility of determining the routes, estimating the



LOCATION OF PROPOSED RAPID TRANSIT SUBWAY

cost and submitting the routes to the electors is the function of the Rapid Transit Commission. The plan provided for a train-operated two-track rapid transit route 13.3 miles in length along Vernor Highway across town in the direction of the long axis of the city, which is 8 miles from north to south and 19 miles from east to west. In its passage across town the route crosses five industrial and six residential belts, terminating at the great plant of the Ford Motor Company at River Rouge, which employs 95,000 workers, whose homes lie in every quarter of the city area of 139 square miles. Within a service area of ½ mile on each side this route serves 22 per cent of the residential population of 1,500,000 and 30 per cent of the industrial population of 450,000. There are 27 stations on this line. The rapid transit line crossed 27 of the 29 car routes and twelve of the bus routes of the surface lines, and the stations were located at these transfer points.

In addition, the plan provided for betterment of the surface transportation facilities by putting seven of the major street-car lines underground through the highly developed downtown business district in short sections of subways, to be built on rapid transit specifications and

thus made available for train operation when extended. There were two of these short sections, or subway dips, one on Woodward Ave., the main north and south artery of the city, to run from near the ferry station on the Detroit River to Temple Ave., 1.2 miles, with three stations. The second section was to occupy Grand River Ave. from Second to Randolph and continue out Madison Ave. to St. Antoine, 1.3 miles. There were four stations at important streets, besides two central turnaround stations, one on each side of Woodward Ave., with underground corridor connections to subway stations on Vernor rapid transit line and Woodward subway car line, all in the half-mile circle about the City Hall.

Underground operation of street cars within the limit of these subway sections would take 40 per cent of the car movement off the surface and thus relieve traffic congestion in the business district, which has been saturated for three years. Operation on the seven routes going underground would be raised from 4 miles an hour now possible on the surface to 12 miles an hour. Altogether, by these subways and the train-operated line connections, a betterment of 15 per cent was expected in passenger-carrying capacity of the surface lines.

Financially the plan provided for issuance of faith and credit bonds under the 2 per cent authorization of the Michigan law for rapid transit purposes only in the amount of $54,600,000, being 60 per cent of the whole cost, estimated at $91,000,000. The remaining 40 per cent was to be financed by mortgage bonds on the system, issue of which also is permitted under the law. These bonds were to be carried and retired by the operation of the financial plan recommended by the commission in 1923 which was approved by the electors in 1924 and again in 1925, when it was resubmitted because of minor changes made by the legislature of that year.

This plan provides for distribution of cost, including service and complete amortization, in accordance with benefits as follows: 17 per cent to city at large, to go on the tax roll over a ten-year period, commencing on approval of the routes; 51 per cent to locally benefited property, to be levied when lines go into operation on the basis of benefits ascertained from assessors' records during the construction period of five years and to be paid over a period of ten years; 32 per cent to the car riders, to be paid through fares. Whatever amount was placed on tax roll would operate under the law to reduce the amount of faith and credit bonds. On this plan the rider is relieved of fixed charges on permanent way, but pays the fixed charge on equipment. On a ten-cent fare and 32,000,000 revenue passengers, it is believed that the rapid transit line could have met operating expenses and fixed charges amortizing at 1 per cent. Forty-three million revenue passengers were expected.

The financial plan was designed and the joint project was approved by Daniel L. Turner, consulting engineer. Estimates of construction costs and operating revenues were favorably reported on by Edward Dana, manager, Boston Elevated, at the request of John C. Lodge, Mayor.

The local press was unanimous in support of plan, but took united action too late in a counter-campaign engineered by group of prominent citizens and the most heavily interested property owners subject to the special assessment. The primary reasons for the defeat of the plan are given as magnitude, lack of preknowledge of the proportions which the Common Council would put on the tax roll, doubt that enhancements would cover a proportion of cost to be assessed on benefited property, and no previous delimitation of the assessment district. The opposition was active in misrepresenting these features and magnifying the probable amounts of tax and assessment.

A review of the history of projects carrying bond issues in Detroit indicates that three submissions of this project to vote may be required before it is approved. Mayor Lodge has already ordered the commissions to prepare a new joint plan for submission in November.

DOWNTOWN DISTRICT, DETROIT, SHOWING LOCATION OF SUBWAYS FOR STREET CARS AND RAPID TRANSIT LINES

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Unusual Methods for Underground Surveys

REVIEWED BY ROBERT E. HORTON
Consulting Hydraulic Engineer, Albany, N. Y.

ELEMENTS OF GEOPHYSICS as Applied to Minerals, Oil and Gas—By Dr. Richard Ambronn, Göttingen. Translated by Margaret C. Cobb, Ph.D. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 372, including 63 pp. of bibliography; 84 illustrations, mostly line cuts. $5.

This is essentially a work on special methods of underground surveying. The book includes not only prospecting for minerals in the ordinary sense but also the determination of the depth, dip and character, both of the rock floor and of large isolated rock blocks underneath the mantle rock or surface soil deposits. The methods described are perhaps more likely to interest mining than civil engineers. Some of these methods are newly developed and have as yet been tested abroad to but a small extent and in America, with few exceptions, not at all.

The underlying idea is to use the known physical properties of materials forming the surface layers of the earth's crust for the purpose of determining the position and character of underground formations. Briefly, the methods of underground exploration given in this book may be described as follows: (*a*) gravitational; (*b*) magnetic and electrical; (*c*) radioactive; (*d*) seismic; (*e*) thermal.

This is a thoroughly scientific treatise of the highest order, crowded with valuable physical data and with one to a dozen authorities cited in almost every paragraph. The extent of research and investigation involved is illustrated by the fact that the book is accompanied by a bibliography of more than 1,700 entries, nearly all of which are directly referred to in the text.

The possibility of determining—as can certainly be done in some cases with a good degree of accuracy and without test pits or borings—not only the depth and configuration of underground rock masses but the type of strata, the stratification itself and the location and character of faults—appeals strongly to the imagination. The reviewer has not the slightest doubt that the methods of underground exploration described in Dr. Ambronn's book can, if properly used, singly or in combination, be of great and immediate service to civil engineers in the study of tunnel locations, deep foundations of various kinds and particularly in the study of dam sites. It is proper to note that, to secure best results in the application of the methods described, a considerable knowledge of experimental physics should be coupled with a thorough comprehension of the geology of the region explored. Unfortunately the proportion of civil engineers sufficiently grounded in physics and geology to appreciate and use this book may be rather small.

Magnetic and electric methods of underground surveying have developed rapidly and have recently been used to some extent in the United States with good success, particularly where the geologic data for the locality are fairly complete and a high order of geologic knowledge is applied in the interpretation of the results. Geologic methods alone do not always lead to a direct indication of the depth and character, for example, of isolated rock masses or bedrock underneath a dam site. Coupled with the methods described in Dr. Ambronn's book, quantitative information of a surprisingly complete character may often be obtained without tests or borings. The methods are not 100 per cent perfect and in some cases the results obtained have been poor. The methods, however, are new and the situation is something like that of attempting to determine the coefficient of roughness to be applied to a stream channel under some conditions for which no experimental data are available. As these new methods are more and more applied and records kept of the indications of the electrical instruments, and in conjunction with the actual conditions found when the site is uncovered, these data will form a valuable adjunct to the electrical method of exploration by affording a means of interpreting the tests in the light of the results found elsewhere under similar conditions.

Most engineers will find Chapter VII (62 pp.), relating to underground exploration by seismic methods, with artificial earth tremors, particularly illuminating and instructive. Here, as elsewhere in the book, data are given showing a comparison between the indicated results and the actual underground conditions.

Such a book as this, representing the life work of a master and at the same time a critical review of all that has gone before on the same subject, is not always a best seller. Such books are, nevertheless, the best books and such a book goes farther than a dozen handbooks to advance the outposts of engineering. Incidentally, this book clearly illustrates the close relationship between engineering and the sciences of physics and geology. The engineer works with the materials existing within and on the surface of the earth, and these are the same materials the description and classification of the properties and the occurrence of which form the basis of the sciences of physics and geology. It is to be hoped that the publication of this book and the application of advanced methods in underground exploration may tend to bring engineers and even the faculties of technical schools to a better realization of the fundamental importance of physics and geology to those who seek to attain higher eminences in the engineering profession.

Thanks are due to the publishers for giving the English-speaking scientific and engineering public a translation of Dr. Ambronn's timely and exhaustive monograph. The book is well printed and well bound, direct, lucid and authoritative in style and should be in every engineering and scientific library.

Soil Investigations for Foundations

FOUNDATIONS: The Examination and Testing of the Ground Preliminary to the Construction of Works, Methods and Appliances—By William Simpson, M.Inst.C.E., M.Inst.Struct.E.; Formerly Chief Engineer, Port of Sunderland; Consulting Engineer. [The Glasgow Text Books.] London: Constable & Co. Cloth; 6x9 in.; pp. 256; 231 illustrations, mostly line drawings. 18s.

The title given is a misnomer for this volume, as it is devoted in its entirety to geological and soil conditions as related to foundations, with full discussion of the various methods of making investigations. Covering the subject of foundations from this standpoint of investi-

gation, the author has presented a most complete study of almost every known method. The book is interesting not only from its complete coverage but also in presenting many methods of foundation investigation that are typically European and practically unknown here.

Although the opening chapters deal with geological conditions and the final chapters discuss test pits and soil bearing values, the greater portion of the book is devoted to borings of every conceivable type. Borings on dry land and under water are treated under separate headings. Wash, percussion and rotary borings are each discussed at length as applied to various conditions.

On the whole, the volume presents a detailed treatment of an important engineering subject, which, though written from a British viewpoint, are applicable in many ways to similar problems in this country.

Rainfall Extremes in Great Britain

BRITISH FLOODS AND DROUGHTS—By C. E. P. Brooks, D.Sc., Honorary Secretary, Royal Meteorological Society, and J. Glasspoole, M.Sc., Ph.D., Professional Associate, Institution of Water Engineers. London: Ernest Benn, Ltd. Cloth; 5¼x8½ in.; pp. 199; 15 illustrations. 10s.

Those not already informed on the subject will be surprised to learn that extensive systematic rainfall records in Great Britain date from about 1860, or only ten years earlier than in the United States. More surprising is the fact that for 60 years the work was done privately by the British Rainfall Organization. At the beginning of this century there were 3,500 of these observers who "were sending in accurate and strictly comparable figures of daily or monthly rainfall." This number was increased to about 5,000 when the work was taken up by the Meteorological Office in 1919.

The highly commendable and interesting volume now before us is divided into three parts: Great rains and floods, droughts and variations of rainfall. Each of the first two divisions is prefaced by a chapter on causes. Special features of Part I are the wet year 1927, the wet summer of 1924, two wet spells in 1903, the rainy seasons of the '70s, historic rains and the great Thames flood of 1928. In Part II particular attention is given to the drought of 1921, the dry year 1887, dry years of the eighteenth century and historic droughts of the Middle Ages.

By recourse to the old chronicles and various earlier writings, the authors sketch both heavy rains and great droughts in Great Britain since the Roman occupancy. The earliest known rainfall records for England were started in 1677, and from that time on there were scattered records here and there, but just how many and how continuous the book does not make clear. With the aid of reliable records classed as "standard" the authors have worked up a system by which they classify great floods and droughts in Great Britain for nearly 2,000 years.

Apparently the authors are not very strong believers in definite weather cycles. They prefer to use the word "recurrence." Various periodicities are examined and a number of curves are presented. The law of probabilities is not applied to the data available.

The book contains a wealth of detail regarding floods and droughts in Great Britain, sometimes with extensions of given occurrences westward to Ireland and eastward through Europe, and in a few instances over the globe. It is well worth the attention of engineers generally, since in one way or another they and their professional work are vitally affected by rainfall.

Much in Small Compass

THE ARITHMETIC OF SEWAGE-TREATMENT WORKS—By Karl Imhoff, M.Am.Soc.C.E., Chief Engineer Ruhrverband, Essen, Germany. Authorized translation by Gordon M. Fair, Assistant Professor of Sanitary Engineering, Harvard University, Cambridge, Mass. New York: John Wiley & Sons. London: Chapman & Hall. Flexible; 5x7 in.; pp. 99; 32 line cuts. $2.

Seldom is so much basic material on an important branch of engineering put in such small compass as in this handy little volume. The whole range of current sewage treatment is covered, with most attention given to tank treatment—naturally enough, considering the author's noteworthy contributions to that branch of the subject.

Although the book is based largely on Dr. Imhoff's "Taschenbuch der Stadtentwässerung," the "underlying material" was "revised and rewritten" by Dr. Imhoff to make "it of the greatest possible service to the American engineer," says the translator.

After a few pages on the composition of sewage, the book takes up screens, skimming tanks, grit chambers, sedimentation tanks, sludge and its digestion, gas collection (for utilization), sludge drying, chlorination, biological processes and activated-sludge tanks. Consideration is also given to sewage treatment for isolated buildings, institutions and industrial plants, and sample computations for sewage treatment. A short, well-selected bibliography, a useful table of conversion units and an index round out the book.

The volume justifies the use of "Arithmetic" in its title and carries out the intent of Dr. Imhoff, expressed in his Preface: "This little book is intended to assemble in small space the methods of computation commonly employed by sanitary engineers in the design of sewage-treatment works." A wide circulation of the book in all English-reading countries seems assured.

Contractors for a Century

SONS OF MARTHA: A Historical and Biographical Record Covering a Century of American Achievement by an Organization of Master Builders—By Dixon Merritt. New York: Mason & Hanger Co., 52 Vanderbilt Ave. Cloth; 6x9 in.; pp. 319; illustrated. $3.

Contracting organizations are rarely long active. For most of them the space of life lies within a decade; a number endure for 25 years, and a half-century witnesses only a scattered few still living. When a construction company lasts beyond a century and is as active a force in the engineering world after 105 years as at any time in a long career of major construction accomplishments, its history is worth narrating.

Such a narration is embodied in this volume, published privately by the Mason & Hanger Company, which has just finished the 80-ft. deep cofferdam pier foundations of the Hudson River bridge and is now carrying on one of the most difficult subway construction operations on New York City's great underground railroad system. The book is one that every contractor should be privileged to read that he may renew confidence in the worthiness of his vocation and gain inspiration for higher development of contracting skill, integrity and responsibility.

A personal narrative is difficult to epitomize; chapter titles tell little of the true nature of pages which are part biography and part reminiscence and all of which are written for the family circle of the author. Briefly, the book tells of the work of the contracting firm which C. R. Mason established in 1825 (he had begun contracting in 1819 or 1820) and handed on to H. P. Mason, his son, in 1886, who in turn passed it to his partner, H. B.

Hanger, in 1906, after whose death in 1926 direction went to S. B. Mason, grandson of the founder. From the building of almost the first railway—the Midlothian Railway, 11 miles long, in 1829—to its present work on the New York City subways the Masons have been railway builders. However, in the early nineties, when the rush of railway expansion had ceased, attention was turned to other works which called for large movements of earth and rock: the Chicago drainage canal; the Catskill aqueduct; then, with the war, cantonments and powder-plant work, and lastly, subway and foundation construction. The story of all these works is told, and particularly the stories of the men whom the Masons gathered about them and who with the old firm or in businesses established by themselves have made engineering construction history. The book in brief is a personal record of a family of contractors through a hundred years of construction in America.

German Municipal Government Since 1918

CONTEMPORARY MUNICIPAL GOVERNMENT IN GERMANY —By Bertram W. Maxwell, Ph.D., Professor of European History and Political Science, Washburn College. Baltimore, Md.: Warwick & York. Cloth; 5x8 in. pp. 162. $2.50.

In small compass the author has packed much information on municipal government in Germany since the revolution of 1918. By way of background he gives a brief historical sketch covering the period from medieval times to the German revolution.

In the chapter on The Relation of Cities to States it is brought out that German municipalities have less autonomy now than before the revolution. This is due largely to changes in national and state taxation, which leave the cities without their former control of their own finances. Under the title The Organs of Government the city council and also the magistrat are reviewed. The latter is in effect a large executive committee, appointed by the city council, and in some respects superior to the council itself. The magistrat should not be confused with the executive and administrative branches of government. These are headed by the burgomaster, who is the chief executive officer of the city. He is elected by the city council generally for twelve years. Scanty information is given regarding the other executive municipal officials.

There are separate chapters on the police, municipal finance, municipal enterprises and other topics. Municipal ownership in Germany is quite extensive.

Under the title Special Legal Unions, Greater Berlin is considered. This is virtually a metropolitan government, set up in 1920. It includes twenty administrative districts, of which six are within the old city of Berlin. The total area covered is 320 square miles and the population is nearly 4,000,000. There are separate governments for the twenty administrative districts and also for Greater Berlin. The latter is the general form already described, with a council, magistrat and burgomaster. A separate chapter deals with the Proposed National Municipal Code of Germany, and the appendix gives the code in full.

In his conclusion the author states: "It is too early to evaluate the changes brought about by the revolution." He says further: "The post-revolutionary municipal governments of Germany are attempting to blend two seemingly irreconcilable elements: democracy and efficiency. Universal suffrage in cities opened the way for democracy. So far German city government has remained efficient."

So compact, instructive and up to date a little volume as this one may be expected to have wide reading among those interested in municipal government in America and elsewhere in the world.

To Be Read and Emulated

SKYSCRAPERS and the Men Who Build Them—By Col. W. A. Starrett, M.Am.Soc.C.E., M.Am.Soc.M.E. New York and London: Charles Scribner's Sons. Cloth; 6x9 in.; pp. 347; with frontispiece portrait of the author and other halftones. $3.50.

One of the principal reasons for recommending "Skyscrapers" for engineers to read is that some one of them may be moved to emulate Colonel Starrett and produce as good a book on some other phase of civil engineering. "The most distinctively American thing in the world," is the characterization Colonel Starrett applies to the steel skeleton building, and on this he builds a fascinating story. But there are other equally enthralling subjects in the roster of civil engineering activities which would lend themselves to a technically sound, semi-popular presentation. Nothing but good can come to the civil engineering profession from the wider understanding of its motives and methods that such books can bring. Every engineer, too, stands to benefit by being reminded of the importance and glamour which the general public attaches to the work he has elected to follow.

In "Skyscrapers" Colonel Starrett recounts the history of the structural steel frame building from its beginnings, about 1875, to the present day, giving at the same time a comprehensive account of the methods and practices used in modern building work. Belonging to a family of builders and being an engineer and contractor of note himself, Colonel Starrett has seen this history unfold. Also, he has borrowed generously from facts collected and recorded by that scholarly engineer of the American Bridge Company, Robins Fleming. The result is probably as accurate an account as is possible in dealing with such a controversial subject as the origin of the steel frame building.

Historically, the book is divided into three periods—1876-1892, 1892-1914 and 1914 to date. Taking as a base line the Centennial Exposition at Philadelphia in 1876, there is first described the skyscraper's early days, especially in its birthplace, Chicago. It is next brought through the scientific development period of improved steels and faster and safer elevators to the time of the World War, when obsolescence of then existing buildings became apparent and the era of modern metropolitan rebuilding was inaugurated. From this point forward the book is based on a functional plan describing in an interesting and readable manner such subjects as: Planning and Forethought; Contract Relations; Design Considerations; Types of Builders; Excavations, Shoring and Bracing; Foundations; Structural Steel Manufacture; Erection Practices; Use of Building Stone; Ceramic Masonry and Decorative Interiors; Labor and Building; Building Trades Apprentices; and Cost Considerations.

It will be surprising if Colonel Starrett does not receive some criticism for his treatment of some of the latter chapters. In them he has used his book as a setting to defend and to promote his own ideas on such subjects as labor and building, trades apprentices, construction industry organization, etc. Rather than being a subject for adverse criticism, this attempt to educate the public on such matters is highly commendable and the author is well within his rights, however much some may question his opinion. More engineers should embrace the opportunity that a book offers to place civil engineering on a stage from which some of its problems

can be better seen by the layman, the jurist, the banker and others who control the purse and legislative strings upon which construction relies.

"Skyscrapers" represents one of the best efforts in recent years to explain the civil engineer to the general public. It has the additional value of being interesting and worth while for the engineer reader.

Flood-Control Plan Attack

FLOODS IN THE VALLEY OF THE MISSISSIPPI A NATIONAL CALAMITY: What Should Be Done About It—By J. P. Kemper, C.E. New Orleans: National Flood Commission, 1014 Chartres St. Cloth; 5½x8½; pp. 225; illustrated.

The present plans for the control of floods in the Mississippi Valley below Cairo, including the Chief of Engineers' plan as adopted by Congress and the plan of the Mississippi River Commission, are ruthlessly attacked by Mr. Kemper in his review of the flood situation in the lower river valley. After reviewing the history of the Mississippi River floods and of the levee system by which, heretofore, attempts have been made to control the floods, Mr. Kemper takes up the approved plan for flood control point by point and shows wherein, in his opinion, it is faulty or grossly inadequate to meet flood conditions. This is followed by a discussion of the Mississippi River Commission's plan in detail, the report of the reservoir board and the special board consisting of Major Gen. Edgar Jadwin, Brig. Gen. D. H. Jackson and Carleton W. Sturtevant.

Mr. Kemper is radically opposed to the "levees only" policy of the Mississippi River Commission, so closely adhered to during past years, but shows little favor for the floodways and spillways proposed by the Chief of Engineers as a modification of that plan. He believes that the money spent on the Bonnet Carré spillway is pure waste, holding that it will never come into use because of the great quantity of water which will go down the Atchafalaya River valley under the plan as proposed.

Mr. Kemper shows a wide knowledge of the lower river, but he makes little constructive use of his knowledge in this attack upon the present plan of flood control. From the few things he does say constructively it would appear that he believes that floods can be overcome by a combination of all possible means of checking the flow of water into the main river, by the use of reservoirs on the tributaries, by reforestation and by contour plowing. It may be assumed that he indorses the proposals of the Atchafalaya Basin Protective Association, because he prints in full an appeal to the special board from that association. Finally, he pleads for the re-enactment of the legislation included in the Newlands act of 1907, which was repealed in 1919.

Not Found Wanting

URBANIZATION: Its Effect on Government and Society—By John Giffen Thompson. New York: E. P. Dutton & Co. Cloth; 6x9 in.; pp. 683. $6.

Not found wanting is the verdict of the author after a careful study of urbanization through the centuries. In fact, he reaches this conclusion at almost every step of his detailed survey under the heads: civic liberty, economic freedom, political liberty, contributions to democracy, political knowledge, inventiveness and leadership, government efficiency, health, morals, religion and preparedness for war. Much of the book consists of documented summaries of opinion pro and con, duly weighed, balanced and supplemented by the author.

Publications Received

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ETHICS OF PUBLIC UTILITY VALUATION—By John A. Ryan, D.D., LL.D., Professor of Moral Theology and Industrial Ethics at the Catholic University of America. Washington, D. C.: National Popular Government League. Paper; 6x9 in.; pp. 32. 25c.

Reviews U. S. Supreme Court decisions and takes issue with reproduction cost principle, which the author declares is based on ethical rather than economic grounds and as applied is unfair.

FOREIGN MARKETS FOR IRRIGATION MACHINERY AND EQUIPMENT—Prepared in collaboration with the Bureau of Reclamation of the Department of the Interior from reports submitted by representatives of the Departments of Commerce and State and other sources. Industrial Machinery Division, U. S. Department of Commerce. Brief forewords by Julius Klein, director, Bureau of Foreign and Domestic Conference, and Elwood Mead, commissioner, Bureau of Reclamation. Paper; 6x9 in.; pp. 156; illustrated. 30c. from Superintendent of Documents, Washington, D. C.

Despite its misleading title (the pamphlet contains very few marketing data), this publication is commendable. It surveys the status and general prospects of irrigation in the various countries of the world and summarizes by continents and countries the areas under irrigation, total areas and population.

FUNDAMENTALS OF COLLEGE PHYSICS—By A. L. Fitch, University of Maine. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 336; 18 halftone portraits and 100 figures. $2.50.

Designed as introductory college course. The author's conception is that "a very clear thread of Conservation of Energy" runs through Physics, and that "the discussion of a physical phenomenon should mean more to a student when he can understand why it happens that way in terms of previous knowledge than if a formula is given without the reasons underlying that formula"; or that the problems given to the student should be "Physics problems rather than problems in Arithmetic."

ILLINOIS STATE WATER SURVEY: Three bulletins issued from Urbana, Ill. Cloth; 6x9 in.; pp. about 100 each; illustrated. No. 25, *Precipitation Studies*, 1921-27, by A. M. Buswell, Chief of the Survey, R. A. Shive and S. L. Neave. No. 26, *Depth of Sewage Filters and Degree of Purification*, by A. M. Buswell, S. I. Strickhouser and others. No. 27, *Factors Affecting the Efficiency and Design of Farm Septic Tanks*, by E. W. Lehmann, R. C. Kelleher and A. M. Buswell; Joint publication with Illinois Agricultural Experiment Station.

THE LIFE OF GEORGE CHAFFEY: A Story of Irrigation Beginnings in California and Australia—By J. A. Alexander. New York and Melbourne: The Macmillan Co. Cloth; 6x9 in.; pp. 379; illustrated. $10.50.

THE LITTLE LIBRARY OF SELF-STARTERS—By Robert R. Updegraff. Six Volumes: A New "Bag of Tricks" for Every Business; Old Specification; The New American Tempo; The Sixth Prune; Obvious Adams; The Subconscious Mind in Business. Chicago: A. W. Shaw Co. Ornamental boards, cloth back, paper label; 5x7 in.; about 60 pp. in each. Single volumes, 75c. each; the set $4, in picture-board box.

"Inspirational" essays for the man or woman who wishes to catch up with the procession or, if already at the front, get well ahead.

OM NATURLAGAR FÖR TRAFIKEN OCH DESS LEDER (On Natural Laws for Traffic and Traffic-Routes)—By Captain H. N. Pallin, C.E., Stockholm, Sweden. Reprint from *Teknisk Tidskrift*, Nos. 43 and 47, 1928. Paper; 9x12 in.; pp. 13; illustrated. Address the author for copies.

The illustrations show various types of street plans, actual and theoretical. A 400-word summary, in English, leads to the conclusion that taking into account "the laws of periodical variations and psychological influence of traffic," cities should be planned "along quite new lines."

RECOMMENDED MINIMUM REQUIREMENTS FOR PLUMBING—Report of Subcommittee on Plumbing of the Building Code Committee. Paper; 6x9 in.; pp. 280; illustrations and tables. 35c. from Superintendent of Documents, Washington, D. C.

Revision of 1923 report entitled "Recommended Minimum Requirements for Plumbing in Dwellings and Similar Buildings," with basic principles "extended to all types of buildings."

SELECTED PAPERS: Proceedings of Fourth Annual (W. Va.) Conference on Water Purification—Edited by E. S. Tisdale and L. V. Carpenter. Morgantown, W. Va.: West Virginia University. Paper; 6x9 in.; pp. 130; a few illustrations.

STANDARD SPECIFICATION FOR STEEL HIGHWAY BRIDGES. Second Edition. Ottawa: Secretary, Canadian Engineering Standards Association, 178 Queen Street. Paper; 6x9 in.; pp. 78; 50c.

Specification for silicon steel added. Revisions made as to axial tension and loading conditions. Some sections deleted.

STANDARD SPECIFICATIONS. Eleventh Edition. Pittsburgh, Pa.: Carnegie Steel Co. Paper; 5x7¼ in.; pp. 129; line cuts and tables.

THE SUBMERGED WEIR AS A MEASURING DEVICE—By Glen Nelson Cox, Research Fellow in Hydraulic Engineering. Madison, Wis.: The University of Wisconsin Engineering Experiment Station. Paper; 6x9 in.; pp. 151; 41 illustrations, 39 tables.

TOLL BRIDGES IN CALIFORNIA, Investigation and Report on —Sacramento, Calif.: Highway Division, Department of Public

Works. [Compiled by the Bridge Department of the Division of Highways, under the direction of C. E. Andrew, bridge engineer. C. H. Purcell is state highway engineer and B. B. Meek director of public works.] Paper; 6x9 in.; pp. 140; illustrated with maps and line drawings, some on folding plates.

Notes taken from this valuable report appeared in *Engineering News-Record*, April 11, 1929, p. 606. The main conclusion of the report is "that the further construction of privately owned toll bridges should be prohibited."

UNDERPINNING SCIENCE: An Engineer's Ideas on What Actuates the Universe—By Edward Godfrey, Professional Building, Pittsburgh, Pa. Published by the author. Paper; 6x9 in.; pp. 76; illustrated, $1.

WATER RESOURCES OF CONNECTICUT, Report on—By Roscoe Henry Suttie, C.E., Associate Professor of Civil Engineering, Yale University. Hartford: State Geological and Natural History Survey. Paper; pp. 168; 7 figures and maps; many tables.

Besides a general survey of the water resources of the state, including rainfall, runoff, great storms, flood and minimum discharges and flow-duration curves, this noteworthy report contains a list of cities and towns having public water supplies, brief descriptions of the works and a summary of sources of supply, public and private ownership and population supplied.

WATER TRANSPORTATION, 1926—Bureau of the Census, U. S. Department of Commerce. Paper; 6x9 in.; pp. 172; tables. 25c. from Superintendent of Documents, Washington, D. C.

The fifth census of water transportation in the United States. With minor exceptions includes all craft of 5 tons net register and over, regardless of means of propulsion and whether engaged in inland, coast or foreign service. The first water-transportation census was taken in 1880, and covered steam-propelled vessels only.

Letters to the Editor

Operating Costs for Passenger Automobiles

Sir—In the Aug. 2, 1928, issue of *Engineering News-Record* on p. 169 you published an article on operating costs for passenger auto by N. D. Douglas.

Having kept an itemized account of the cost of operating my car for 52 months, I am inclosing a tabulation which I have no doubt will be of interest against figures submitted by Mr. Douglas.

COST OF OPERATION, STUDEBAKER LIGHT SIX, FIVE-PASSENGER COUPÉ, MODEL 1924, WEIGHT 2,855 LB., COST SECOND-HAND $1,200

Year	Miles	Gal. Gas	Cost of Gas	Oil and Grease	Garage	Tires	Batteries	Adj. and Repairs	Misc. Exp.	Ins.	Lic.	Miles Per Gal.	Total for Year	Cost Per Mile, Cents
1924*	2,504	225	$48	$9	$34	$2	$7	$2	$1	$49	...	11.1	$152	6.1
1925	6,785	545	114	28	96	37	15	29	2	48	$40	12.5	409	6.1
1926	6,414	490	103	26	96	42	17	74	...	7	40	13.1	405	6.3
1927	4,935	370	8	29	104	41	7	23	9	6	40	12.6	339	6.9
1928	6,971	523	104	22	81	38	10	186	50	50	40	13.3	579	8.3
	27,609	2,153	$447	$114	$411	$160	$56	$314	$62	$160	$160		$1,884	

* Four months only.

Interest $1,200 at 6 per cent — $6 per month; 52 months	$312
Depreciation	800
Operating expenses	1,884
	2,996
Expense per mile, 10.85c.	

Make, Studebaker Light Six. Model, five-passenger coupé, 1924. Weight, 2,855 lb. List price, $1,700. Cost second hand, $1,200. Mileage, 6,300. Condition, excellent. Purchased Aug. 25, 1924. Total mileage, 33,909. My mileage, 27,609.

Time Items	Douglas —Cents Per Mile—		Raynor —Cents Per Mile—		
Interest	1.24		1.13		$6 per month, 6 per cent
Insurance	0.31		0.58		on $1,200. Fire, theft
Garage	0.83		1.49		and liability, $10,000-
License	0.59		0.58		$20,000. $8 per month
	2.97		3.78		$40 per year.
Mileage Items					
Gas	1.61		1.62		20.8 per gal., incl. 3c. tax
Oil	0.31		.41		
Tires	0.98		.58		
Maintenance	1.24	4.40	1.56	4.46	
Depreciation	3.16		2.90		
	7.30		7.07		
Totals	10.27		10.85		

In explanation of the inclosed table you will note that no liability insurance was carried in 1926 and 1927. In 1928 the motor was overhauled; a new spring, rear fender and bumper were required and charged to repairs. Miscellaneous included $35 for repainting. The car was driven only by the writer and mostly over surfaced roads on short trips and city taxi service.

C. W. RAYNOR.

Portland, Ore.,
Feb. 4, 1929.

The Engineer's Status and Salary

Sir—Much has been written by engineers in an effort to improve the status financially and professionally of the engineer. There have been sporadic efforts here and there to raise salary schedules in certain municipal, county, state and federal offices, or to bring about agreement on better conduct and fees for practicing and consulting engineers. In the writer's judgment, the engineer's worst enemy is the engineer, and this hostility is manifested in many different ways. As long as the large majority of engineers are content to work for mere wages as members of salaried staffs, the engineer cannot hope to attain true professional standing in the sense that physicians, attorneys and dentists usually acquire such prestige. An exceedingly small percentage of the physicians, attorneys and dentists are content to work for salaries, whereas most engineers never get out of the wage-earning class.

New York City recently took a step in the right direction by employing a well-known firm of consulting engineers for sewage disposal. Salaried city and county engineers should attempt to have all or part of their work put on a fee basis. Engineers who reach high executive positions in industrial organizations or as city managers should advocate having the engineering work done, whenever possible, by engineering firms instead of maintaining salaried staffs, which, in many cases, must be operated at low pay and sometimes at low efficiency. Many city and county engineers will be surprised to find how high their costs are, when all cost factors are included in the percentage for engineering work. It can be demonstrated that efficient engineering offices maintained by practicing and consulting engineers are generally able to do engineering work better and cheaper than isolated staff organizations. If this were not true, engineers would have to cease looking upon their work as professional work and begin to think about trade unionism as the best way out.

Practicing and consulting engineers should place their organizations on a profit-sharing basis, so that each member of the staff will assume that professional dignity and enthusiasm which cannot come unless he feels that he is really part of the organization and not merely an underpaid employee with no really vital part in the work of the firm. Practicing and consulting engineers must maintain their practice in a manner that will not invite criticism of sloppy work, excessive profits or unduly high costs for construction. Some of the work by practicing engineers in connection with road district work in the Southwest a few years ago dealt a body blow to the engineer's professional standing in that section. In general, practicing and consulting engineers should pay more attention to the code of practice which was adopted Jan. 18, 1927, by the American Society of Civil Engineers.

In the writer's opinion, improvement in the status of engineers along the lines mentioned could be effected thus: (1) by propaganda among students in engineering colleges carried on by the teaching staff and also by lectures delivered by prominent practicing and consulting engineers; (2) by committee work of the engineering societies calculated to improve the operations of practicing and consulting engineers; (3) by publicity work carried on by practicing and consulting engineers.

ARTHUR W. CONSOER,
Consoer, Older & Quinlan,
Consulting Engineers.

Chicago, Ill.,
Feb. 25, 1929.

News of the Week

Chicago Could Stop All Lake Diversion Within Six Years

Engineers So Testify Before Hughes at the Hearing on Diversion Held at Washington

THAT Chicago is in a position to stop all lake diversion for sewage dilution purposes within the next six years was the tenor of testimony presented on resumption of the hearings in Washington April 15 before Charles E. Hughes, special master appointed by the U. S. Supreme Court. Sanitary engineers appearing for the states were unanimous in declaring that, with treatment of all sewage and filtration of all water supply, there would be no health menace from the discharge of the final effluent into Lake Michigan.

Construction Program Outlined

Essentially the same construction program was advocated by each of the four sanitary engineers who took the stand. By progressive completion of the work contemplated or already under way in the North, West, Southwest and Calumet sections, they said, the present diversion of 8,500 sec.-ft. could be reduced to 6,500 during the current year, 5,000 by the end of 1932, 3,000 by 1933 and be totally shut off by 1935. These figures do not include pumpage reaching the sewers through the water-supply system. The opinion was given that the water-filtration works can be designed and finished by the end of 1934.

The continued diversion of 1,000 to 2,000 sec.-ft. to aid navigation in the Chicago River would not affect the above program, it was emphasized. As to the efficiency of the proposed treatment methods, the consensus was that the suspended matter in the raw sewage could be reduced 95 per cent, the bacterial count 95 per cent and the biochemical oxygen demand 96 per cent.

In addition to the plans of the Chicago Sanitary District, it was asserted that all fear of water contamination could be removed by placing the water-supply intakes at a point north of the city. This testimony was given by L. R. Howson, George Gascoigne, D. W. Townsend and J. W. Elms.

Stormwater Problems

On the problem of stormwater, Prof. H. W. King, of the University of Michigan, reported the results of hydraulic investigations. It is assumed that in any event Chicago will not be forced to discharge stormwater into the lake. Therefore means must be provided to send a maximum volume of polluted stormwater down the Drainage Canal without a reversal of flow in the Chicago River. Assuming again that treatment of stormwater would be impracticable, such a reversal would jeopardize the water supply. Professor King's testimony was to the effect that all danger of reversal can be eliminated.

To pass the estimated peak of 10,000 sec.-ft. of storm flow, it is necessary to increase the canal discharge from the normal 5,000 sec.-ft. to 10,000 by gate operation within 4½ hours, taken as the time of concentration. The present gates are at Lockport, 36 miles from the lake. It is proposed to build additional gates at Western Ave., 6.6 miles from the lake, below which there would be a 7-ft. drop under normal conditions. Because of this drop and because of the shorter distance which the upstream wave of acceleration must travel to reach the lake, the Western Ave. gates would, it was stated, greatly decrease the time necessary to establish a flow of 10,000 sec.-ft. Professor King estimated that this could be done in 24 minutes with a little time added for gate operation.

City as Codefendant

Simultaneously with the hearings, the city of Chicago is petitioning to be admitted as codefendant with the State of Illinois and the Chicago Sanitary District. The stated purpose is to have a say in protecting the water supply from what Chicago terms a "pollution which will inevitably produce grave epidemics of typhoid fever and other water-borne diseases."

Civil Engineers Now Members of Engineering Council

The formalities in connection with the joining of the American Engineering Council by the American Society of Civil Engineers were completed on April 9, when the society's application for membership was approved by the council delegates. Last year the members of the American Society of Civil Engineers voted favorably upon the proposition to join the Engineering Council and the board of direction authorized application for membership to be made at its meeting in January.

The following delegates from the American Society of Civil Engineers have been selected: For the term ending Jan. 1, 1930: Baxter L. Brown, St. Louis, Mo.; L. L. Calvert, Philadelphia, Pa.; A. J. Dyer, Nashville, Tenn.; George T. Seabury, New York; C. E. Grunsky, San Francisco; Frank M. Gunby, Boston. For the term ending Jan. 1, 1931: H. S. Crocker, Denver, Colo.; A. J. Hammond, Evanston, Ill.; John C. Hoyt, Washington, D. C.; Anson Marston, Ames, Iowa; Francis Lee Stuart, New York; Frank M. Williams, Albany, N. Y.

Nickel Plate Railway Asks to Acquire the Wheeling & Lake Erie

Now Under Order to Give Up Wheeling Stock It Now Holds—Not Competing With Railway

REQUEST for permission to acquire control of the Wheeling & Lake Erie Railroad through stock ownership has been made to the Interstate Commerce Commission by the New York & St. Louis Railway (Nickel Plate) in one of four petitions filed with the Interstate Commerce Commission on April 15.

Recently the Interstate Commerce Commission ordered the Nickel Plate, the New York Central and the Baltimore & Ohio to divest themselves of the stock of the Wheeling & Lake Erie which they had bought from John D. Rockefeller, Jr., the commission claiming that for these three roads to hold control of the Wheeling was in violation of the anti-trust law. Subseqeutly the New York Central and the B. & O. sold their stock to the Allegheny Corporation, a holding company controlled by the Van Sweringens, the owners of the Nickel Plate. The Nickel Plate now asks the commission to vacate that order, as it no longer applies to the two other roads. In addition, it asks to be permitted to issue common and preferred stock to buy the stock of the Wheeling. Finally, it asks permission to intervene in opposition to the pending application of the Pittsburgh & West Virginia Railway for authority to acquire stock control of the W.&L.E.

The Nickel Plate makes its claim for control of the Wheeling on the basis that it needs the Wheeling to give it access to the Pittsburgh region and to important coal fields, also that it is not in competition with the Wheeling for traffic.

New York Now Has Gasoline Tax Law

Governor Roosevelt of New York has signed the gasoline tax law imposing a tax of 2c. per gallon on gasoline used for motor fuel on the highways of the state. The law goes into effect May 1.

Of the money received 75 per cent is to go into the state treasury to be appropriated by the legislature for construction and maintenance of roads, 5 per cent is to be paid to the city of New York to reduce taxes and 20 per cent is to be distributed among the counties to be used in road maintenance in proportion to the ratio that the total mileage of roads within the county, outside of cities and incorporated villages, bears to the total state road mileage.

American Concrete Institute Reorganizes Its Work

At the annual meeting of the American Concrete Institute in Detroit in February it was unanimously decided to discontinue publication of an annual *Proceedings*, comprising the papers and discussion of the annual meeting, and to substitute therefor a monthly journal. As the result of this step a complete reorganization of committee work has now been announced. All former committees are discontinued. Plans are under way for the organization of 37 new committees set up in nine departments, these departments covering the following:

Research—Interested in interpretation of test data or the initiation or direction of tests.

Materials — Interested in production and distribution of materials used in concrete work.

Engineering Design—Interested in structural design or the supervision of construction of such work.

Architectural Design—Interested in architecture and sculpture or supervision of such work.

Specifications—Interested in production of specifications for material, services or workmanship on behalf of the owner.

Field Construction — Interested in monolithic concrete work, including job equipment, organization, etc.

Shop Manufacture — Interested in manufacture and distribution of factory-made concrete products.

Use Requirements—Interested in unusual or special qualities in concrete on account of its use in unusual construction or where subject to extraordinary exposures.

Joint Efforts—Interested in joint work with representatives from other societies and work in which the principal interest is clearly in two or more of the foregoing departments.

Although the interests of these departments overlap, the personnel of the departments have no direct administrative functions except through an advisory committee, so that the overlapping of the interests involves no conflicts of authority. The new advisory committee is composed of a chairman, A. R. Lord; the secretary of the Institute, Harvey Whipple; the chairman of the program committee, S. C. Hollister; the chairman of the new publications committee, W. A. Slater; and one representative from each of the nine departments. This advisory committee reports to the board of direction, which under the bylaws of the Institute creates all committees, assigns their tasks and names the chairmen.

In general, the new committee organization comprehends the use of larger total personnel than heretofore and the study of a much larger list of subjects. Besides the monthly journal, it is planned that the summation of existing information be adapted into an American Concrete Institute Manual of Practice.

California Railroad Commission Officials Study Boulder Dam

A. G. Mott, chief engineer of the California Railroad Commission; A. V. Guillou, assistant chief engineer, and Charles E. Grunsky, chief gas and electric engineer, upon invitation of the Board of Public Service Commissioners of the city of Los Angeles, recently made a special trip to Boulder Canyon for the purpose of making a thorough inspection and study of the Boulder dam water storage and hydro-electric project. As this project is expected to have a great influence upon the future of southern California and a special bearing upon the public utility situation, it was considered important that these officials make a careful study on the ground.

Sewage-Works Association Planned for New York State

Plans are being made for the organization of a New York State Sewage-Works Association. Interested engineers and operators are invited to attend a meeting at the Capitol Assembly Parlor, Albany, N. Y., at 2 p. m., Saturday, May 4, to adopt a constitution.

World Engineering Congress to Meet in Chicago

In connection with the World's Fair Centennial to be held in Chicago in 1933 it is proposed to hold a World Engineering Congress, and the Western Society of Engineers has been selected to take the leadership in the project. President Garcia has been designated to call together representatives of the local sections of the four founder societies to perfect an organization.

Two Resign From N. Y. State Engineers License Board

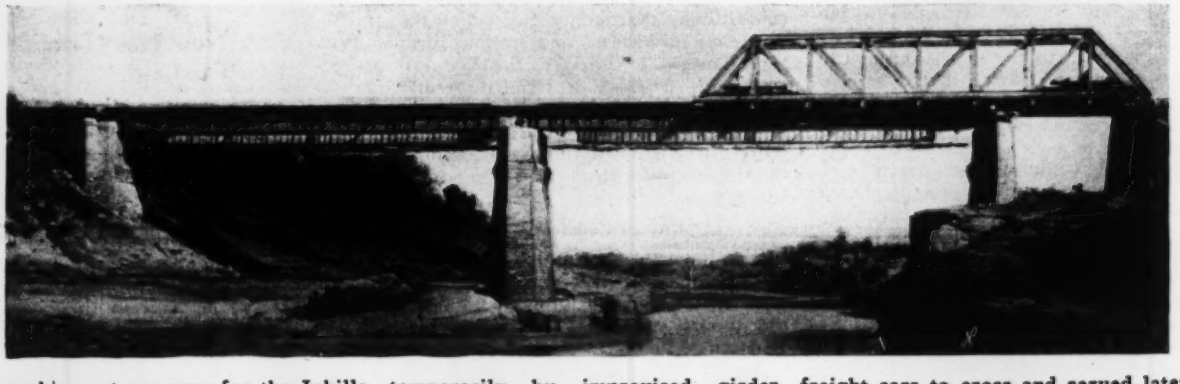
Walter G. Eliot, vice-chairman, and Percy E. Barbour, member of the Board of Licensing for Professional Engineers and Land Surveys of the State of New York, resigned on April 15. Colonel Eliot represented the American Association of Engineers on the Board and Colonel Barbour represented the American Institute of Mining and Metallurgical Engineers. Both men give as their reason for resigning the lack of harmony between the board and the assistant commissioner for higher professional education of the University of the State of New York, Dr. James Sullivan, and their disapproval of the legislation for the modification of the engineer license law advocated by Dr. Sullivan which failed to pass at the recent session of the state legislature.

Maryland to Spend $6,361,000 for Public Improvements

Both houses of the Maryland General Assembly, in session at Annapolis, have passed a series of loan bills urged by the state administration which provide for several million dollars in loans, the money to be used for various public improvements during the next two years.

One of the bills is a $3,361,000 loan measure for new buildings additions, etc., for the use of state institutions. Another provides $1,500,000 for bridge construction in various parts of the state. A third is for $1,500,000 for roads.

BRIDGE RENEWAL IN INDIA



Launching a truss span for the Johilla River bridge on the Bengal-Nagpur Railway, India. After the original spans were carried away by floods in 1927, communication was reopened temporarily by improvised girder spans built of available old 60-ft. girders spliced together and reinforced by a third girder on the under side. That structure enabled single freight cars to cross and served later as falsework in launching the new truss spans placed in 1928. (Picture reproduced from the 1928 report of the Indian Government Railway Board.

Dozen Papers Read Before Florida Section, A.W.W.A.

Officers elected at the meeting of the Florida Section of the American Water Works Association, held at Jacksonville, Fla., April 10 and 11, were: Chairman, R. W. Reynolds, superintendent, West Palm Beach Water Company; vice-chairman, C. H. Eastwood, Jacksonville representative of Wallace & Tiernan; secretary (re-elected), F. L. Filby, engineer, Florida Board of Health, Jacksonville. The next meeting will be held at Gainesville, Fla.

A dozen papers were read. Need for the conservation and protection of water supplies of Florida, with special reference to those from the Ocala limestone formation, was urged by Dr. Herman Gunter, state geologist, Tallahassee, who stated that this area, which extends over parts of Florida, Georgia and Alabama, had never been completely mapped, nor had stream gagings been made. The section adopted a resolution requesting the state legislature to provide funds for co-operative mapping and stream gaging by the federal government.

Beautification around water-works plants and the securing of good will by visits of citizens to the plant were advocated by W. H. Weir, engineer, Georgia State Board of Health, and T. M. Early, superintendent of water-works, Cocoa, Fla.

Safety Talks to Be Broadcast Weekly by National Council

A series of safety talks sponsored by the National Broadcasting Company in co-operation with the National Safety Council will be put on the air every Saturday evening commencing April 20. The speaker of the first program will be Charles M. Schwab, of the Bethlehem Steel Corporation, discussing "Safety as a Factor in Industry." The first program will commence at 7 p.m. Eastern Standard time, the remaining programs being scheduled for 7:15 Eastern time. In following programs, the speakers include Louis F. Butler, president, Travelers Insurance Company; P. E. Crowley, president, New York Central Lines; Robert P. Lamont, Secretary of Commerce; Grover Whalen, New York commissioner of police; Joseph E. Sheedy, executive vice-president, U. S. Steamship Lines; James J. Davis, Secretary of Labor. The June 1 talk will be delivered by Miller McClintock, director of Erskine Bureau, on the subject of "Making Our Highways Safe."

Utah to Ask Conference on Colorado River Agreement

Toward a subsidiary agreement allocating the 7,500,000 acre-ft. of water provided by the Colorado River compact, Gov. George H. Dern of Utah has announced his intention to request a conference between the adjacent states in the near future. Shortly after Utah's ratification of the compact, the state legislature forwarded a resolution to the U. S. Department of the Interior asking a survey and classification of the lands in Wyoming, Colorado, Utah and New Mexico which would be subject to reclamation or power development under the Colorado River agreement. Governor Dern pointed out that most of the area involved is government land over which the states have no control. He stated the belief that "no satisfactory four-state agreement can be reached in advance of a careful study of the agricultural and power potentialities of the respective states." The pending conference, however, is expected to lead at least to a preliminary understanding.

Tunnel and Meters Topics of N.E.W.W.A. Meeting

Breaking away from its practice of decades, which has been to hold monthly luncheon meetings in Boston, the New England Water Works Association met on April 10 at Waterbury, Conn. The morning was used for an inspection trip to the Shepaug tunnel, which is to bring an additional water supply to the city of Waterbury, under the guidance of Robert A. Cairns, city engineer of Waterbury. After returning to the hotel and having luncheon a paper on the tunnel was read by Mr. Cairns. The tunnel work was carried on in a leisurely fashion in view of the fact that the city had taken time by the forelock in starting its construction. At first, the work was done by force account. Progress was slow and there was much overtime put in to complete a day's cycle of work until the pay of the men was based on a standard advance of 6 ft. a day. The rate of progress speeded up to an average of 10 to 11 ft., and that within what had previously been set as a normal working day of eight to nine hours.

There were three papers on meter maintenance. H. W. Griswold, designing engineer, Hartford Water-Works, took up small meters, and Roger W. Estey, superintendent of water-works, Danvers, Mass., large meters. The installation and maintenance of Venturi meters was the subject of the third paper, by A. B. Coulters, of the Builders Iron Foundry. Mr. Griswold stated that maintenance begins at the uncrating of the meter on its arrival from the manufacturer. Ideal maintenance is directed to minimum of cost and maximum percentage of recorded flow. At Hartford the practice now is to carry meters to the point of replacement, insert one in good condition and take away the one needing attention. This increases somewhat the clerical work but makes for economy.

Mr. Estey said he had found under-registration of large meters on systematic inspection, with a loss of revenue corresponding to from 100,000 to 180,000 g.p.d. at 13c. per 1,000 gal. In large meter installations in Danvers provision is made for testing the meters for rate of flow in place without interfering with the supply to consumers, a bypass being provided. Tests are made in an average of five to six hours.

Sewage-Works Extension at Rochester, N. Y.

The sewage of the Maplewood district of Rochester, N. Y., including a portion of that from the Eastman Kodak plant, is to be carried across the Genesee River to the Irondequoit sewage-works instead of being treated by a separate plant, as has been under consideration. The Kodak plant industrial wastes have been almost completely separated from the sewage and will be treated separately by means yet to be determined. From the high levels of the Maplewood district, the sewage will go to the Irondequoit plant by gravity, being carried under the Genesee River by an inverted siphon to the main interceptor. From the lower level territory in the Maplewood district the sewage will be pumped to the main interceptor. The estimated cost of this work is $162,000.

A contract has been let for two additional Riensch-Wurl screens at the Irondequoit plant, to be placed in pockets previously prepared for them. The contract for the screens was awarded on March 29 to the Shevlin Engineering Company, New York City, at $14,000 each. The work mentioned follows the general recommendations of a report made to the city of Rochester on March 2 by Metcalf & Eddy, consulting engineers, Boston. This firm has made designs for the changes entailed by the new screen installation and is now designing a small pumping station for the sewage from the low level area of the Maplewood district. Metcalf & Eddy have recommended a comprehensive pollution survey of Lake Ontario waters on both sides of the Genesee River, and it is expected that the city will adopt this recommendation. When the lake survey has been completed, Metcalf & Eddy will probably report on further enlargement of the Irondequoit sewage-works.

Harold W. Baker is commissioner of public works at Rochester and John F. Skinner is sanitary engineer.

Norfolk & Western Ry. Seeks Terminal at Norfolk

The Norfolk & Western Railway Company is negotiating with the city of Norfolk, Va., for terminal properties consisting of land, tracks, wharves and grain elevators which the city owns at Sewalls' Point, Va., known as the Norfolk Municipal Terminals and Grain Elevators. The property includes 300 acres of land, a modern grain elevator with service track and concrete bulkhead and two merchandise piers of concrete with their service tracks. The facilities cost the city $5,461,000. The properties are now operated by the Norfolk Tidewater Terminals, Inc. The railway company proposes to lease the properties for a term of 22 years.

The railway company has asked the Interstate Commerce Commission to grant a certificate if such is necessary before it can take over and operate the terminal.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Speculation Rife on Gen. Jadwin's Successor as Chief of Engineers—Contractors Oppose Cement Tariff

MOST of those who follow War Department matters closely are of the opinion that the precedent will be followed and that, with the retirement of General Jadwin on Aug. 7, the Assistant Chief of Engineers, Gen. Herbert Deakyne, will succeed him. There has been some activity on behalf of Col. William P. Wooten, but indications now are that his friends will join in an effort to secure for him the nomination for Assistant Chief Engineer. Largely as a result of his work as chairman of the spillway board, there is strong support for Colonel Wooten on the west bank of the Mississippi.

There are some, however, who think President Hoover may be inclined to upset precedent and go further down the list to pick a Chief of Engineers who will have a number of years to serve before reaching retirement age. General Deakyne would have less than 2½ years to serve. Attention also is called to the fact that recent recommendations by the Chief of Staff have not followed the seniority rule. In making his selection for the Chief of Infantry he passed over 166 officers senior to General Fuqua. These and other indications are cited to indicate the possibility that the regular order will not be followed in the selection of the Chief of Engineers or his assistant.

Most of the current speculation centers around the office of the assistant chief. A widely held impression is that Colonel Kutz, who ranks just below General Deakyne, is not likely to be chosen, since he has had special distinction in having served as Engineer Commissioner of the District of Columbia. This is a $10,000 job and usually is regarded as a much desired climax of a military career. By this same token, Colonel Ladue, the present Commissioner for the District of Columbia, is eliminated by those who take this point of view. Colonel Barden and Colonel Schultz, who rank next in order, have not come in for much discussion in this connection. Colonel Burgess is Governor of the Canal Zone and probably would not be detached from that important duty at this time. Colonel Hoffman, now in charge of the First New York District, has served on the Mississippi River Commission as division engineer at New Orleans and as a result is a very real contender for the position as assistant chief. Both Colonel Cheney and Colonel Ferguson, who occupy the next places on the list, are highly regarded. The possibility of the appointment of either of these men must be taken into consideration.

In view of what happened in General Fuqua's case, there are some who think the assistant chief may be chosen from the list of lieutenant colonels. In that connection, the names of George R. Spalding, Max C. Tyler and Ulysses S. Grant, 3d, are coming in for particular mention.

A.G.C. Opposes Cement Tariff

Protesting that the cement industry is discriminating against the private contractor, the Associated General Contractors has resolved to oppose a tariff on foreign cement until the practices they complain of are stopped. The particular practice to which the contractors object, it is stated, is the tendency of the cement interests to sell at lower prices to municipalities and state governments than to construction companies. Because of this price discrimination, the contractors feel that the only way they can get consideration in bidding on public work is by being able to base their prices on lower cost foreign cement.

United States Wood May Regain Favor in Tropics

That proper chemical treatment will permit lumber from the United States to regain favor in tropical markets was the opinion reached at a conference sponsored by the National Committee on Wood Utilization held in Washington March 28. The main speaker was Dr. Thomas E. Snyder, senior entomologist, U. S. Department of Agriculture, who has just returned from an inspection of the wood-preservation experiments in the Canal Zone and the West Indian possessions.

Wood is rapidly losing ground in the tropics, even for uses where it is preferred to other materials, Dr. Snyder said, because of the failure of untreated or improperly treated lumber under termite attack. However, he declared, wood need not be abandoned if proper steps are taken to meet the local needs. Sometimes insulation from the ground by use of metal shields or other means is sufficient. In areas more seriously infested, all the woodwork must be treated with creosote, zinc chloride, or some proprietary compound, creosote being preferable for wood in contact with the ground. Untreated California redwood and pitchy Southern pine have been found satisfactory in many instances. Brush treatments are ineffective.

Axel H. Oxholm, director of the committee, pointed out the importance of maintaining our present export trade in lumber with the tropics. Large quantities of low-grade lumber not readily sold at home on account of the long hauls necessary to get it to the nearest domestic markets are finding an outlet in near-by tropical countries. The direct result of the conference was the adoption of a resolution asking the National Committee on Wood Utilization to make a study of best practices in protecting wood construction from termite attack and decay in the tropics, and to make this information available to those interested in this subject.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 24-26.

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual meeting, Washington, May 2 and 3.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston; annual convention, Memphis, Tenn., May 13-16.

AMERICAN SOCIETY FOR TESTING meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

* * *

The Pacific Northwest Section, American Water Works Association, will hold its annual meeting in Spokane, Wash., May 17 and 18.

The Fourth Annual Conference of secretaries of engineering societies will be held on June 6 and 7 in the rooms of the Western Society of Engineers in Chicago. A general invitation has been extended to the secretaries of engineering and allied technical organizations.

The New York Section of the American Water Works Association will hold its spring meeting in Elmira, N. Y., on May 2 and 3. On the program are papers on Scientific Control of Filter Plants From the Operator's Viewpoint, the New Water Supply for Albany, N. Y.; the Hydraulic Gradient and Its Significance in Water-Works Maintenance, and Allowable Leakage in Cast-Iron Pipe. On the first day there will be a round-table discussion for superintendents.

The Seismological Society of America, by a mail vote of the board of directors, has decided to hold a meeting on April 30 and May 1 in conjunction with the fourth annual meeting of the Eastern Section of the society at Fordham University, New York City. Another meeting of the society will be held on June 20 at the University of California, in connection with the thirteenth annual meeting of the Pacific Division of the American Association for the Advancement of Science.

The Academy of Political Science will hold its semi-annual meeting on Wednesday, April 24, at Columbia University, New York City. Three sessions will be held, at 10 a.m., 2:30 p.m. and 8:15 p.m. Railroad consolidation will be the topic discussed at the three sessions, and addresses will be made by Walker D. Hines, J. P. Blair, Pierpont V. Davis, Emory R. Johnson, John J. Esch, James S. Parker, W. N. Doak, Bird M. Robinson, William L. Ransom, Simeon D. Fess and Daniel Willard.

Personal Notes

RALPH H. CHAMBERS, formerly vice-president of the Jarrett Chambers Company, has been elected vice-president of the John W. Doty Corporation, of New York.

R. L. VAN NOCKER, city engineer of Owatonna, Minn., for the past six years, is now employed in the same capacity by the city of Albert Lea, Minn. He will have charge of the operation, maintenance and new construction work of streets, alleys, sewers and water-works.

JOHN H. BROOKS, JR., has been elected superintendent of sewers of Worcester, Mass., in place of ANDREW B. HOLMSTROM, resigned. Mr. Brooks has been engineer of inspection in the department during the past nine years. He is a graduate of Worcester Tech.

Dr. DIETLER THOMA, of the Technical University of Munich, an authority in the design of hydraulic machinery and especially known for his work on governors and turbines, will give a series of lectures at the Massachusetts Institute of Technology during September.

N. S. BUCKBEE, formerly district manager for the Corrugated Bar Company at Buffalo, N. Y., and recently with Wright & Kremers, of Magic Falls, N. Y., has joined the construction department of Gannett, Seelye & Fleming, Inc., and will be located in the Harrisburg office.

W. A. KELLY, engineer appraiser, has been assigned by the Federal Farm Loan Bureau to the Kansas City Joint Stock Land Bank, of Kansas City, Mo., for the purpose of making a report on drainage conditions in the Little River Valley in southeast Missouri. During the past eleven years Mr. Kelly has been engineer appraiser with the Federal Land Bank of Omaha.

ROLPH TOWNSHEND, formerly inspector for the Maryland State Roads Commission, has been promoted to the position of district engineer of District No. 2, with headquarters at Chesterton, Md. This district comprises the counties of Cecil, Kent, Queen Annes, Talbot and Caroline. Mr. Townshend succeeds AUSTIN F. SHURE, who was recently made engineer of surveys.

C. A. HEINZE, formerly assistant electrical engineer of the Los Angeles Bureau of Power and Light, has been appointed assistant chief engineer and general manager of the Department of Water and Power, following the recent reorganization, upon recommendation of H. A. Van Norman, chief engineer and general manager of the department. Mr. Heinze is president of the Los Angeles Electric Club.

LESLIE M. MATHER has joined the organization of Gannett, Seelye & Fleming, Inc., to be general superintendent of the corporation's properties in Argentina. These properties are a part of the Intercontinents Power Company and Mr. Mather will have his headquarters at the main office at Buenos Aires, S. A. Mr. Mather was formerly with the J. G. White Corporation and later with the Pennsylvania Power & Light Company as superintendent of the Harrisburg Light & Power Company.

C. M. MATTHEWS, of Lake Village, Ark., has been named president of the Southeast Arkansas Levee Board, to succeed W. D. TROTTER, resigned. C. R. BATES, of Dermott, is the new member to fill the place vacated by Mr. Trotter.

WILLIAM B. POWELL, consulting traffic engineer, of Buffalo, N. Y., has become associated with Ernest P. Goodrich, consulting engineer, of New York City. Mr. Goodrich and Mr. Powell will undertake street traffic and related studies for cities and other governmental units and will act as consultants to municipalities on traffic matters. Mr. Goodrich announces that his recent retention by the Chinese government as its engineering adviser will not hamper his acting in a consulting capacity for American and European clients, because he will be absent from the United States not more than a few months each year.

HARRY J. KIRK, after fifteen years' experience in the Ohio State Highway Department, successively as division engineer, maintenance engineer, construction engineer, chief engineer and finally as director of the department, has opened an office in Columbus, Ohio, as consulting engineer, specializing in road and street problems. For many years Mr. Kirk has been active in the Mississippi Conference of the State Highway Departments and the American Association of State Highway Officials. He has also been prominent in the work of the Highway Research Board of the National Research Council, being at present chairman of the committee on highway finance of that organization. He is now serving as vice-president of the Engineers Club of Columbus.

Obituary

ANDREW WALLBERG, of Toronto, died recently at Battle Creek, Mich. He was 61 years old. Mr. Wallberg, who was born in Sweden and educated at the University of Iowa and the Massachusetts Institute of Technology, had extensive interests in paper mills, power plants and other enterprises in Ontario and Quebec. He and associates built the munitions plants at Leaside, Ont., during the war. He was president of the Lake St. John Power & Paper Company and had been associated with the Toronto Durant Company and the Canadian Wire & Cable Company.

JOHN JOSEPH SHEA, identified with drainage projects in the Mississippi Valley for 25 years, died in Memphis, Tenn., on April 6. He was 62 years old. Mr. Shea entered the construction business during the World's Fair in Chicago in 1893. Four years later he organized the Canal Construction Company and for a quarter of a century his company has been engaged in drainage and canal construction along the Mississippi from Cape Girardeau to New Orleans.

LOUIS QUIEN, of Elizabeth, N. J., died on April 10 at the age of 77. Mr. Quien had served as city engineer of Elizabeth and as an engineer for the county, the State of New York, the South Pennsylvania Railroad and the United States government. He made a survey for a ship canal in Mexico for James B. Eads. All the trolley lines in Elizabeth and all but one in Staten Island were built by him. He was secretary and treasurer of the New Jersey Dock & Bridge Building Company.

WILLIAM C. HATTAN, chief engineer, Carolina, Clinchfield & Ohio Railway Company, died at Erwin, Tenn., on March 25. Mr. Hattan was born in Lexington, Va., in 1875 and graduated from Washington and Lee University in 1899. Upon graduation he went into railway construction work and continued in that work on various railway lines in the Middle Atlantic States until 1916, when he went to Texas to become general superintendent in charge of construction of the Missouri, Kansas & Texas Railway belt line and terminal construction for the firm of Thomas & Jones. Subsequently he was in charge of construction on the aviation field at Memphis, and then area superintendent in charge of construction of Area E of the U. S. explosives plant at Nitro, W. Va., for the Thompson-Starrett Company. In 1919 and 1920 Mr. Hattan was in private practice at Meyersdale, Pa., and in 1920 he was appointed chief engineer of the Carolina, Clinchfield & Ohio Railway.

C. PHILIP COLEMAN, president, Mount Hope Bridge Company, died in Washington April 13 after a short illness which turned into pneumonia. Mr. Coleman left his home in New York about ten days ago for a short vacation in the South and becoming ill while on the train was removed to a hotel in Washington. He was nearly 64 years old. Mr. Coleman had held various important executive positions of an engineering character since he graduated from Lehigh University in 1888 with an M.E. degree. Starting as a clerk for the Lehigh Valley Railroad, he later became assistant general superintendent. In 1903 he was elected secretary and treasurer of the Singer Sewing Machine Company, in which position he was in charge of the erection of the Singer Building in New York City. Subsequently Mr. Coleman was president of the Sauer Motor Company, president of the International Motor Company and president of the Worthington Pump & Machinery Corporation. He was also assistant to the president of the Bethlehem Steel Company. Mr. Coleman's most recent connections were as president both of the Mount Hope Bridge Company and of the Sandusky Bay Bridge Company.

Construction Equipment and Materials

Steel Joist Specifications Completed for Use

Formulation of a standard specification for steel joists, which has been a major subject of study of the Steel Joist Institute for some time, has been completed and it is now available at the offices of the Institute, 1736 Dime Bank Building, Detroit, Mich. The use of steel joists has grown rapidly and in consequence there has been a variety of opinions as to the proper method of designing and erecting them. It was in order to standardize these methods that the association of steel joist manufacturers was formed in the spring of 1928. At that time Frank Burton, formerly commissioner of the department of buildings in Detroit and at one time president of the Buildings Officials Conference, was retained as consulting engineer. In his announcement of this new specification Mr. Burton relates how the first steel joists were manufactured from sheet steel as early as 1855 and how numerous buildings were constructed of such joists from that time until 1908, when the quantity production of pressed-steel joists was started. All joists were of the solid web type until 1923, when the production of open web joists was begun. Mr. Burton states that about 40,000,000 sq.ft. of steel joists floors and roofs are now being constructed annually in the United States.

The members of the Steel Joist Institute are: Bates Expanded Steel Truss Company, Chicago, Ind.; Berger Manufacturing Company, Canton, Ohio; Concrete Steel Company, New York City; Gabriel Steel Company, Detroit, Mich.; Youngstown Steel Company, Youngstown, Ohio; Ingalls Steel Products Company, Birmingham, Ala.; Macomber Steel Company, Canton, Ohio; McClintic-Marshall Company, Philadelphia, Pa.; and the Truscon Steel Company, Youngstown, Ohio.

Lumber to Be Graded by Moisture Content

The adoption of moisture content provisions as definitions of dry lumber for inclusion in the standard grading rules of the Southern Pine Association was one of the outstanding actions taken at the fourteenth annual meeting of the Southern Pine Association in New Orleans the latter part of March. This is said to be the first time in the history of the lumber industry that the consuming public will be given the opportunity to specify a definite moisture content.

The plan adopted is claimed to eliminate any possibility of green lumber or that which is not properly and thoroughly seasoned to be distributed under the official grading rule of the Southern Pine Association. The plan was adopted after the Forest Products Laboratory at Madison, Wis., had made a survey of seasoning and drying practices at representative Southern pine mills and reported to the association.

Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded during the month of March, 1929, and also the total number of square yards awarded for roads, streets and alleys in the United States for the year 1929 to date as of March 30.

	Sq.Yd. Awarded During March, 1929	Sq.Yd. Awarded From Jan. 1, 1929, to March 30, 1929
Roads.....	2,825,781	10,603,813
Streets.....	2,999,288	5,815,520
Alleys.....	174,842	282,923
Totals...	5,999,911	16,702,256

Business Notes

PHILIP CAREY MANUFACTURING COMPANY, Cincinnati, announces that the differences between it and the Servicised Products Corporation, Chicago, including the pending litigation, have been terminated and that the Servicised Products Corporation is now manufacturing premolded products under a license on patents owned by the Philip Carey Manufacturing Company, including, in addition to patents formerly owned by that company, all patents heretofore owned by the Servicised Laboratories, Inc., relating to premolded products, such as expansion joint, rail filler, track pavement, railroad crossings, construction materials and other like products. Other than as above stated, the two companies are entirely distinct and independent corporations.

TRUSCON STEEL COMPANY, Youngstown, Ohio, announces a new schedule of prices applying to its industrial steel windows and also the publication of a series of books describing these windows. The books cover pivoted windows for use in factory walls, continuous windows for roof monitors and saw-tooth roofed buildings, and projected steel windows of both the industrial and architectural types.

TRACKSON COMPANY, Milwaukee, Wis., announces the appointment of the Cuyahoga Equipment Company, Cleveland, Ohio, as its distributor of tractor equipment for McCormick-Deering tractors.

JOHNS-MANVILLE CORPORATION, New York City, announces that William R. Seigle, formerly vice-president in charge of mines and factories, has been elected chairman of the board of directors, and Lewis H. Brown, formerly secretary and assistant to the president, has been elected president. Mr. Seigle succeeds H. F. Manville, resigned, and Mr. Brown succeeds Theodore F. Merseles, who died March 6. Mr. Seigle has been in the Johns-Manville organization since his graduation from college in 1900. Mr. Brown was associated with Mr. Merseles in Montgomery Ward & Company and went to the Johns-Manville organization with Mr. Merseles in August, 1927.

AMERICAN SPIRAL PIPE WORKS, Chicago, announces a change in its name to the Taylor Forge & Pipe Works, effective March 30, 1929. The company has operated under the old name since 1900. The change in its name at the present time does not involve any change in ownership or capital structure but has been made wholly for the convenience of customers who were not familiar with the company's wide range of products for high-pressure service.

J. C. LINCOLN, formerly president of the Lincoln Electric Company, has been elevated to the position of chairman of the board of directors, and J. F. Lincoln, formerly vice-president, has been promoted to the presidency of the company. J. F. Lincoln has been one of the outstanding figures in the electrical industry and was among the first to promote the use of electric-arc welding as a manufacturing tool.

UNITED STATES CAST IRON PIPE & FOUNDRY COMPANY, Burlington, N. J., announces the manufacture of deLavaud centrifugal cast-iron pipe in 18-ft. lengths and in all diameters from 4 to 12 in., inclusive. A battery of casting machines for the production of these long lengths is now in operation at the company's Birmingham, Ala., plant. It is claimed that the product will be found to measure up in every respect to the present 12-ft. lengths. The longest lengths of pipe heretofore cast in the United States are 16 ft. long; these were manufactured with the vertical sand cast method.

ARMSTRONG CORK & INSULATION COMPANY, Pittsburgh, Pa., announces the consolidation of the offices of all its divisions at Lancaster, Pa., effective April 1, 1929. This involves the removal from Pittsburgh of the general office of the company and all executive offices of the Armstrong Cork Company, cork division, and of the Armstrong Cork & Insulation Company, with the exception of the purchasing department, which will remain in Pittsburgh.

MANCHESTER ENGINEERING & WELDING COMPANY, INC., Manchester, N. H., has been incorporated for the purpose of fabricating structural steel and ornamental iron by the electric-arc welding process in the states of Vermont, New Hampshire and Maine. The company has been in existence about three years during which time it numbers among its major projects a factory building

60 ft. wide by 200 ft. long located in South Portland, Me.

MANITOWOC ENGINEERING WORKS, Manitowoc, Wis., announces the appointment of the following representatives to sell its power shovels, draglines, and clamshell buckets: William H. Ahlers, Kensington Station, Buffalo, N. Y., and the Chadwick Machinery Company, 25th and Clybourn Sts., Milwaukee, Wis.

CLEVELAND TRENCHER COMPANY, Cleveland, Ohio, announces the appointment of A. V. Jones as its general manager. Mr. Jones was until recently merchandise sales manager for the Buffalo General Electric Company, with which he has been associated for the past twenty years.

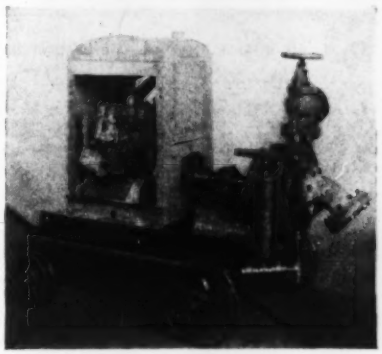
THE UNITED TRACTOR & EQUIPMENT CORPORATION, organized with assets above $125,000,000, has been formed by the merging of a large group of tractor and farm machinery manufacturers. News accounts state that the retirement of the Ford Motor Company from the manufacture and sale of tractors made the organization possible. It is expected that Ford officials will take offices with the company. Among the manufacturing corporations forming United Tractor are the Hughes-Keenan Company and the Roderick Lean Mfg. Company, Mansfield, Ohio; the Perry Company, Perry, Ohio; the Allis-Chalmers Manufacturing Company; the Wehr Company and the Trackson Company, Milwaukee; the Brookville Locomotive Company, Brookville, Pa.; Dorsey Brothers, Elba, Ala.; the C. H. Turner Manufacturing Company, Statesville, N. C.; the Muskogee Iron Works, Muskogee, Okla.; the Brennies Manufacturing Company, Los Angeles; the Ferguson Manufacturing Company, Evansville, Ind.; the Universal Power Shovel Company, Detroit; the Athens Plow Company, Athens, Tenn.; the Moline Implement Company, Moline, Ill. Wilton W. Anderson, of Chicago, was made president and general manager; W. B. May, Buffalo, N. Y., vice-president; E. R. Wehr, Milwaukee, secretary-treasurer, and Walter Stiemke of Milwaukee, assistant secretary-treasurer.

New Developments

New Portable Centrifugal Pump With 3-In. Discharge

A light, compact, portable pumping unit designated as the Penroi pumper and designed for general unwatering work has been announced by the Pennsylvania Pump & Compressor Company, Easton, Pa. The pump and gasoline engine are assembled into one compact unit mounted on a hand-truck chassis. The pump is of the centrifugal single-suction open-impeller type with 3-in. discharge and 4-in. suction openings, capable of handling various capacities up to 350 g.p.m. according to head conditions. The casing is cast iron, of the volute type, and can be adjusted so that the discharge opening may have any one of eight positions. The impeller and shaft bushings can be removed by removing the pump casing, without disturbing adjacent parts or engine alignment. The pump casing is a separate unit bolted to the main frame.

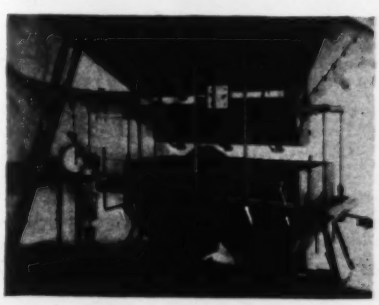
A complete set of fittings consists of



15 ft. of 4-in. smooth-bore rubber suction hose, two hose couplings, foot valve and strainer and a 3-in. angle discharge valve. The pumper is powered by a LeRoi two-cylinder 8-hp. radiator-cooled engine. The pump may be primed by pouring water into the pump through the tee placed between the pump and the discharge valve, using a foot valve to retain it, but where frequent priming is necessary, a special hand priming pump which attaches to the pump suction is recommended.

New Weighing Batcher Uses All-Steel Scale

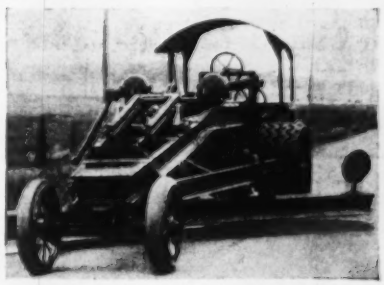
A new weighing hopper equipped with an all-steel scale which is claimed to combine accuracy with ease of operation has recently been developed by the Butler Bin Company, Waukesha, Wis. Among the outstanding features of the hopper are that it ships as a complete unit with the scale attached, and it can be easily installed on any steel, wood or cement bin by merely bolting the frame to which the hopper is suspended over the openings in the bin. Three radial gates, two for stone and one for sand, are claimed to insure accurate control and rapid delivery of aggregates from the storage bin into the hopper. A dial is used to indicate overweight or underweight. Counterbalanced automatic discharge gates allow the weighed batch to discharge into the truck or mixer.



Platform or ground operation may be provided for. The scales meet the specifications of the U. S. Bureau of Standards and where specifications require it the weighing hopper can be equipped with separate full capacity beam and poise for each material to be weighed. The company's bulletin No. 150-B describes and illustrates this new hopper.

New Road Grader Dispenses With Usual Center Circle

A new one-man patrol maintainer being produced jointly by the Minneapolis Steel & Machinery Company, Minneapolis, and the Royer Manufacturing Company, Janesville, Iowa, incorporates several unique features. In the first place the long blade is carried on two members attached to the side frame, these members replacing the usual center circle. The members are carried on ball-and-socket bearings at their forward end and may be raised and lowered or moved sideways. It is claimed that regardless of the angle at which the blade is operated, power is transmitted on a direct line to the cutting edge. The advantages of this feature are increased efficiency and cutting ability from the longer blade at the same time permitting operation at a higher speed. The design is also claimed to eliminate side draft—that is, the tendency of the front end of the unit to slide sideways—and also to eliminate blade chatter. It is pointed out that on a 16-ft. blade



there is an overhang of only 4 ft. from the bearings to each end of the blade.

The blade is controlled by worm gears inclosed and running in oil. There is an adjustable 4-in. ball-and-socket joint from the side arms to the blade-lifting arms. An additional adjustable 4-in. ball-and-socket joint at the bottom of the blade-lifting arm is claimed to eliminate all play to the side member carrying the blade. The blade-shift mechanism is attached to the bottom flange of the side member and is carried on lubricated steel rollers. For the operator's convenience the grader includes easy lifting blade, full view of blade end, independent operation of scarifier, tractor-cranking device at rear of cab, weatherproof cab construction, complete inclosure of cab with curtains or wood glass frames and spring-mounted wooden platform.

The power unit is a 17-28 Twin City tractor with 4½-m.p.h. high speed. The weight of the unit complete with cab and scarifier is 13,800 lb. The blades,

which are of carbon steel 1½ in. thick, are available in 10-, 12-, 14- and 16-ft. lengths. The blade pitch adjustment has six positions. The blade may be shifted sideways 20 in. and upward 16 to 22 in. The main frame consists of 10-in. 20-lb. channels, while the side blade-carrying beams are 8-in. I-beams 11 ft. long. The front wheels are equipped with solid tires, and on the rear wheels single or dual cushion tires are standard equipment.

New Publications

Arc Welders — GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has published two new pamphlets, Nos. 876-B and 874-C. The first bulletin describes the company's type WD-400A arc welder available with belt or motor drive, in stationary or portable types with a current range of 100 to 500 amp. The second bulletin describes the type WD-200A arc welder with belt, motor or gas engine drive in stationary or portable types. The current range on this machine is from 60 to 300 amp.

Steel Castings—GEORGE H. SMITH STEEL CASTING COMPANY, Milwaukee, Wis., has published a booklet entitled "The Story of Smith Co. Steel Castings." The catalog starts with a statement of policy and describes the plant and equipment of the company and then follows through with a step-by-step description of the method of manufacturing steel castings.

Nickel-Chrome Steel — INTERNATIONAL NICKEL COMPANY, INC., New York City, has published in its bulletin No. 13 the results of extensive tests made by T. H. Wickenden, of its development and research department, on the subject of torsion, impact and other mechanical properties of S.A.E. 3130 nickel-chrome steel. Data covering these tests are presented in the form of charts and tables with explanatory comments.

Road Joint Machine—FLEXIBLE ROAD JOINT MACHINE COMPANY, Warren, Ohio, has published a 36-page booklet largely composed of illustrations showing its joint machine as it has been applied to various types of modern road construction—namely, new concrete, resurfacing old concrete, resurfacing old macadam, resurfacing old brick pavements, and also for the construction of concrete base courses for flexible top and brick-surfaced roads. In addition the booklet explains the operation of the machine as it is used in making longitudinal and transverse joints operating on the forms directly behind the finishing machine.

Portable Compressors — CHICAGO PNEUMATIC TOOL COMPANY, New York City, has issued the fourth edition of its bulletin 797 describing its complete line of gasoline engine-driven portable compressors, these being available in 100-, 160-, 220-, 265- and 310-cu.ft. sizes. Descriptions, photographs, specifications, dimensions and weights are included in the bulletin.

Construction, Labor and Materials

E. N.-R. Index Numbers

Cost			Volume		
Apr. 1,	**1929**	**203.40**	**March,**	**1929**	**382**
Mar. 1,	1929	207.78	February,	1929	378
Apr. 1,	1928	206.40	March,	1928	318
Average,	1928	206.78	Average,	1928	287
Average,	1927	206.24	Average,	1927	263
1913.....		100.00	1913.....		100

Large Residential Construction Shows No Decline

Residential construction aggregated $770,000,000 in the first quarter of 1928 and $500,000,000 in the first quarter of 1929, thus registering a decline of 35 per cent. That this decline was not in the larger residential structures is proved by the fact that such building contracts of $150,000 or more total $189,000,000 in the first quarter of 1928 and $237,000,000 in the same period of this year. Even removing from the 1929 value the $40,000,000 new Waldorf-Astoria Hotel contract leaves a little over in favor of this year.

That contract totals for large residential buildings have been as high as this is attributable to heavy lettings for apartments in January and February. March recorded a decline of 30 per cent in these. Removing these figures from the residential totals for the two years leaves $581,000,000 for 1928 and $263,000,000 for 1929.

Building Costs 107 Per Cent Above 1913 Levels

Building construction in March cost 107 per cent more than it did in 1913, according to the index numbers of the American Appraisal Company. The average figure for March is 207.2, compared with 207.1 for February and 205.8 for March, 1928. The *Engineering News-Record* Construction Cost Index was 207.78 at the beginning of March and 203.4 at the beginning of April, 1929, with an average over the month of 205.5. The slight decline was due to revisions in the common labor rate.

Foreign Brick 4.6 Per Cent of New York Total

Duty-free foreign brick entering the port of New York in the latter half of 1928 numbered 28,886,000, or 4.6 per cent of the 625,000,000 common bricks used by local builders in that period. With the exception of 2,000 from Mexico, all imports were from Belgium.

Latest figures from the U. S. Bureau of Foreign and Domestic Commerce show 3,796,000 received in New York in January. Included in these were 675,000 from the Netherlands, being the first importation from that country since June, 1928, when 2,800,000 were received. Holland bricks, though common, are used principally for facing.

Domestic manufacturers are asking for a tariff of $4.50 to $5 per thousand to help bridge the gap between Belgian and American cost to manufacture. Hudson River brick sells for $12 wholesale alongside dock, with the foreign common brick prices $11.

Annual consumption in New York City amounts to 1,264,000,000, or 15 per cent of total production for the United States. Of this, 1,000,000,000 comes from the Hudson River district.

February New Capital Nets $881,513,000

New capital averages $1,000,000,000 per month, and $800,000,000 of it is for corporate and municipal issues. The latter are exclusive of bonds for refunding, foreign and government farm loans.

NEW CORPORATE AND MUNICIPAL CAPITAL ISSUES

	Two Months 1929	Twelve Months 1928
Railroads	3.0	4.9
Public utilities	21.2	25.5
Iron, steel, copper	3.5	2.9
Equipment	.....	0.1
Motors	0.1	0.9
Other manufacturing	12.4	12.0
Oil	7.6	2.9
Land and buildings	10.3	9.7
Shipping	0.6	0.7
Rubber	1.5	0.3
Miscellaneous	39.1	21.4
Municipal	7.9	18.7
Total	100.0	100.0

February net is $881,513,000, which is 60 per cent higher than in that month of 1928. For the two months, and for the year 1928, corporate issues for the various industries are given in the accompanying table in percentages of the total for each period.

Steel Output Makes Record

Steel is being produced in record volume. From 1918 to 1928 the increase in the highest daily ingot rate was from 153,000 to 172,000 gross tons, or 19,000 tons. The March rate was 194,000 tons a day. At the previous rate, this increase was not expected to be reached until 1940. Despite this, orders on the books are increasing and may result in postponing deliveries later on.

This Week's Contracts

Heavy construction contracts, *reported by Engineering News-Record* in the week of April 18, with some comparisons, total as follows:

(In Thousands of Dollars)

	Apr. 18, 1929	Apr. 11, 1929	Apr. 19, 1928	Apr. 14, 1928
Building:				
Industrial	$10,185	$6,711	$4,994	$2,850
Commercial	33,521	47,716	32,366	45,564
St's and r'ds.	12,453	4,835	16,264	18,727
Other eng. constr.	19,237	20,650	27,827	14,787
Total	$75,396	$79,912	$81,451	$81,928
Total, all classes, Jan. 1 to Apr. 18:				
1929				$1,369,981
1928				1,022,155